2005 NPDES Progress Report for the Cedar-Green, Island-Snohomish, and South Puget Sound Water Quality Management Areas

September 2005

Washington State
Department of Transportation

Title VI

WSDOT ensures full compliance with Title VI of the Civil Rights Act of 1964 by prohibiting discrimination against any person on the basis of race, color, national origin or sex in the provision of benefits and services resulting from its federally assisted programs and activities. For questions regarding WSDOT's Title VI Program, you may contact the Department's Title VI Coordinator at (360) 705-7098.

Americans with Disabilities Act (ADA) Information

If you would like copies of this document in an alternative format – large print, Braille, cassette tape, or on computer disk, please call (360) 705-7097. Persons who are deaf or hard of hearing, please call the Washington State Telecommunications Relay Service, or Tele-Braille at 7-1-1, Voice 1-800-833-6384, and ask to be connected to (360) 705-7097.

Cover Sheet

2005 NPDES Progress Report for the Cedar-Green, Island Snohomish, and South Puget Sound Water Quality Management Areas :

The tenth annual report for National Pollutant Discharge System Elimination Multiple Separate Storm Sewer System Permits WASM 10001, WASM 20001, and WASM 30001

Submitted By:

Megan White

Abstract:

This report documents the progress made by WSDOT to protect water quality within the NPDES permit areas between July 1, 2004 and June 30, 2005. Progress is described using performance measures designed to gauge compliance with Stormwater Management Plan commitments, permit conditions and water quality standards. Major sections include a summary of stormwater priorities and spending, maintenance activities to protect water quality, construction site erosion control effectiveness, stormwater treatment facility effectiveness testing and research, and stormwater treatment facility construction.

The greatest achievements in this reporting period include 1) the construction of 42 new stormwater treatment facilities, 2) completion of Environmental Management System tools for continued improvement in the construction site erosion and sediment control, and 3) collection of more data documenting the effectiveness of WSDOT's stormwater treatment facilities.

TABLE OF CONTENTS

LIST OF EXHIBITS

LIST OF APPENDICES

ACRONYMS

ADT – Average Daily Traffic

BMP - Best Management Practices

CFR - Code of Federal Regulations

ESA - Endangered Species Act

ESC Lead - Erosion and Sediment Control Lead

IVM - Integrated Vegetation Management

NPDES - National Pollutant Discharge Elimination System

RCW - Revised Code of Washington

QAPP - Quality Assurance Project Plan

TESC - Temporary Erosion and Sediment Control

TPH - Total Petroleum Hydrocarbons

TSS - Total Suspended Solids

WAC – Washington Administrative Code

WSDOT - Washington State Department or Transportation

Chapter 1 Overview

Why does the Washington State Department of Transportation (WSDOT) manage stormwater?

There are 7,063 miles of highway along with numerous rest areas and park and ride lots in Washington. Collectively those facilities cover at least 35,000 acres with pavement that does not let water soak into the ground. Accordingly, billions of gallons of stormwater run off of state highways each year. The water, along with any pollutants that wash off of the highways, must be properly managed to prevent water quality and flooding problems.

For every inch of rain that falls from the sky onto an acre of pavement, about 25,000 gallons of stormwater is produced.

To address stormwater impacts on a national scale, the federal Clean Water Act was expanded in 1987 to include stormwater from highways. The federal government has delegated the authority to implement the Clean Water Act to the Department of Ecology in Washington. To meet stormwater management standards, WSDOT was required to obtain municipal water quality permits from the Department of Ecology in 1995. The municipal stormwater permits require that highways be designed and maintained to minimize pollution and potential damage to downstream properties.

The municipal permits are called the Phase 1 National Pollutant Discharge Elimination System (NPDES) Permits for Municipal Separate Storm Sewer Systems. They were only required in highly populated areas.

The Clean Water Act also requires WSDOT to get permits from the Department of Ecology to protect water quality on construction projects. These permits ensure that adequate

There are two types of Construction National Pollutant Discharge Elimination System (NPDES) Permits. Individual permits are required for the largest, highest-risk projects. General permits are used for routine projects.

precautions are taken to prevent erosion and spills from contaminating adjacent waters.

What areas are covered by the Municipal Stormwater Permits?

WSDOT has permits that cover King, Pierce, and Snohomish Counties (See Exhibit 1-1). The permits are named after Water Quality Management Areas, as defined by the Department of Ecology, that do not perfectly coincide with county boundaries. The permits cover the following Water Quality Management Areas:

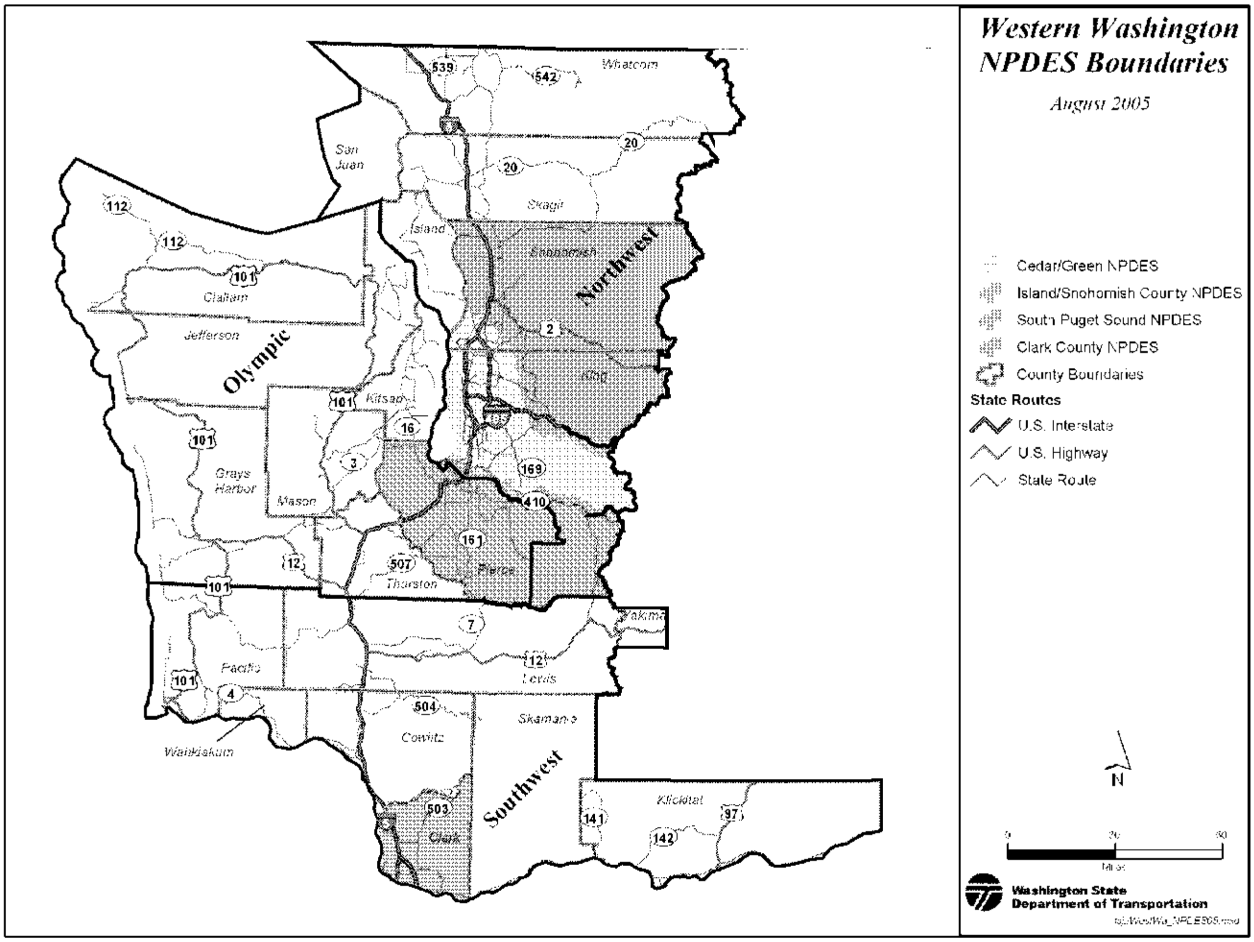
- The Cedar-Green Water Quality Management Area, permit number WASM 10001.
- The Island Snohomish Water Quality Management Area, permit number WASM 20001.
- The South Puget Sound Water Quality Management Area, permit number WASM 30001.

As it was initially presumed that Clark County would also require a permit, WSDOT has also been reporting on stormwater-related activities in Clark County.

What is the status of the permits?

The three permits were initially scheduled to expire on July 5, 2000. Ecology has not yet re-issued the permits. To avoid a lapse in permit coverage, Ecology has extended the above referenced permits, continuing current permit requirements until the next permits are issued. Therefore, the 1995 permit requirements remain in effect at this time. It is anticipated that new permits will be issued in 2006.

Exhibit 1-1
Municipal Stormwater Permit Areas



What is WSDOT's strategy for managing stormwater?

WSDOT prepared a Stormwater Management Plan in 1997 that outlines the long-term strategy for protecting water quality. This plan describes how WSDOT will comply with federal and state laws (40 CFR 122.26, RCW 90.48 and WAC 173-220) and permit conditions. WSDOT is in the process of updating the plan to keep current with changing regulations.

Why does WSDOT create annual reports?

Annual reports are prepared to inform the public and Ecology about progress made to protect water quality. Annual reports describe progress using performance measures designed to gauge compliance with Stormwater Management Plan commitments, permit conditions and water quality standards. The purpose of this 2004 Annual Report is to document stormwater-related activities within the permit areas between July 1, 2004 and June 30, 2005.

Chapter 2 Stormwater Program Priorities and Associated Costs

What are WSDOT's priorities in managing stormwater?

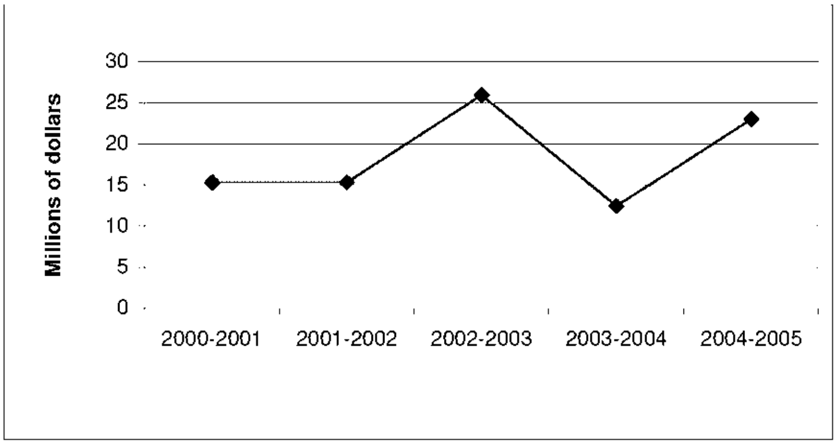
Consistent with the Stormwater Management Plan (SWMP), the following activities continue to be high priorities for WSDOT. The associated costs for priority activities are included in this section in descending order of costs. Each activity is described in further detail in subsequent report sections.

Stormwater treatment facilities are referred to as Best Management Practices (BMPs) in this report. WSDOT's most commonly used BMPs are ponds and wide grass swales called bioswales.

Stormwater Treatment Facilities Construction: WSDOT's top stormwater management priority is to ensure that ongoing highway projects meet requirements for maintaining the existing quality of our state's waters. The cost of building stormwater treatment facilities, known as Best Management Practices (BMPs), in conjunction with highway construction projects exceeds all other stormwater management costs combined. Detailed information on stormwater treatment BMP construction is provided in Section 7.

Stormwater treatment BMP construction costs are linked to the amount of highway construction that occurs each year. Fluctuations in stormwater BMP construction costs as shown in Exhibit 2-1 reflect fluctuations in the amount of funded construction, not a wavering in WSDOT's commitment to provide stormwater treatment.

Exhibit 2-1
Stormwater Treatment BMP Construction Costs



Operations and Maintenance: Operations and maintenance programs are essential to maximizing roadway safety, prolonging the life of highways and ensuring that stormwater BMPs perform at maximum efficiency. In 2004-2005, WSDOT spend $2,280,000 and nearly 34,000 hours on activities that protect water quality. Detailed maintenance program information is included in Section 3.

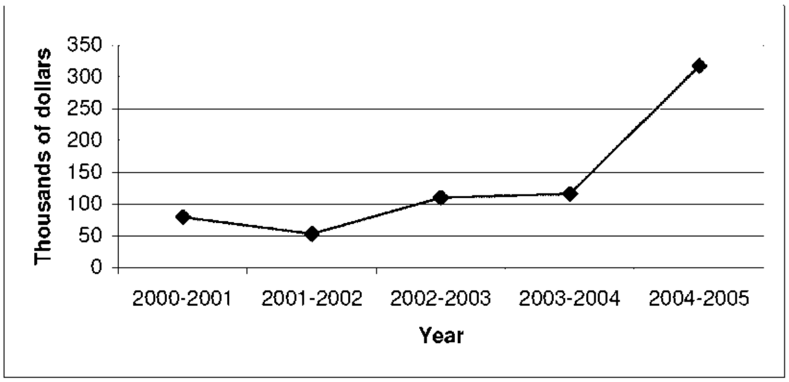
Stormwater Utility Fees: WSDOT pays stormwater utility fees to utility districts that receive runoff from highways. These fees are used to construct new stormwater treatment facilities and maintain the local stormwater systems that convey and treat highway runoff. Current trends related to utility fees include: 1) fewer municipalities are charging fees as fewer areas now lack treatment facilities and 2) utilities fee rates are increasing where new BMPs are required. During the past two reporting periods, WSDOT has paid about $1,600,000 per year in utility fees.

Stormwater Utility fees were recently used to construct two stormwater BMPs next to a stream that crosses Interstate 205 in Vancouver. This location was ranked by WSDOT as one of the sites most urgently needing treatment.

Stormwater Monitoring and Research: Monitoring and research are necessary to 1) determine where treatment is most needed, 2) determine the effectiveness of treatment, and 3) find better ways to clean the water. Detailed monitoring and research program information is provided in Section 6.

Monitoring efforts have substantially increased in recent years and the gathered data has greatly increased our understanding of how effectively stormwater treatment BMPs remove different types of pollutants. Exhibit 2-2 shows WSDOT's recent increases in stormwater monitoring costs.

Exhibit 2-2
Stormwater Monitoring Costs



The research program focuses on, 1) more accurately determining treatment needs, 2) improving the effectiveness of existing BMP designs, and 3) developing new methods for cleaning stormwater, especially Low Impact Development approaches. Research is performed in partnership with state universities, the Department of Ecology, and the Federal Highway Administration. An estimated $340,000 was spent on research in the current reporting period. Since 2000, WSDOT has spent $1,710,000 on stormwater-related research.

Low Impact Development is a name for strategies to keep stormwater spread out so that it can be treated naturally.

Watershed-based mitigation: Sometimes there is no available land along the highway to build stormwater treatment BMPs and little potential to provide a significant benefit to the environment. Such cases often include highways that are completely surrounded by hospitals, schools, strip malls or other buildings and where the nearest streams have long been buried in pipes that can't possibly provide habitat for fish or wildlife.

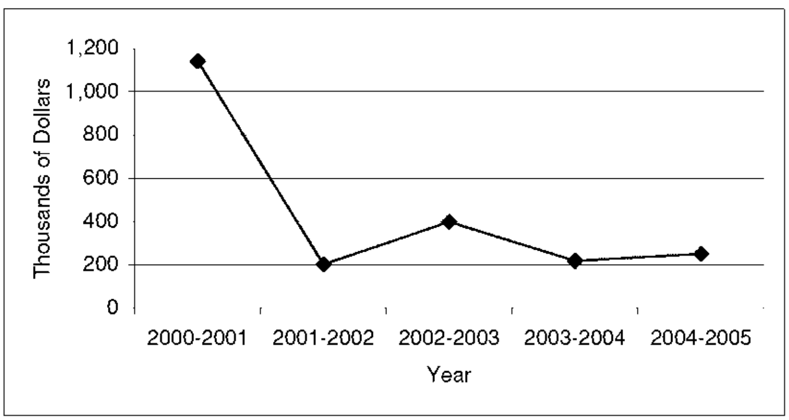
Information on WSDOT's watershed-based mitigation program is provided in section 5.

In such cases, public funds can provide a much greater environmental benefit by improving the conditions in nearby areas that still have available land for installing treatment BMPs and habitat to protect. In the last two years WSDOT has spent $400,000 performing studies to identify such locations for important improvement projects.

Stand-Alone Stormwater retrofit: Most of Washington's highways were built before the Clean Water Act was created and have no stormwater treatment BMPs. WSDOT fixes or "retrofits" these older locations by building ponds and other treatment facilities. When feasible, outfalls are retrofitted in conjunction with new construction projects. In other cases, BMPs are built as stand-alone projects. To date, however, funding for stand-alone retrofit projects has been limited.

Exhibit 2-3 reflects a one-time increase in funding in the 1999-2001 transportation budget. Retrofit expenditures have since returned and stayed at the level observed between 1995 and 1999.

Exhibit 2-3
Stand-Alone Stormwater Retrofit Expenditures



Good news: The transportation budget passed by legislature in the spring of 2005 contains $3.8 million dollars for stand-alone stormwater retrofit projects that may provide treatment in up to 46 locations.

Policy and training: WSDOT's designers and builders need clear policies and training in order to make the right decision on how best to protect water quality. Stormwater policies and design guidelines are provided in the *Highway Runoff Manual* and *Hydraulics Manual*. To keep up with changing regulations and evolving technologies, WSDOT has updated the *Highway Runoff Manual* and the *Hydraulics Manual*, which together provides the policies and design criteria for stormwater treatment. The cost of updating the *Highway Runoff Manual* in

Updating the *Highway Runoff Manual* involves much more than simply updating content. Extensive studies are required in support of policy changes and design criteria modifications.

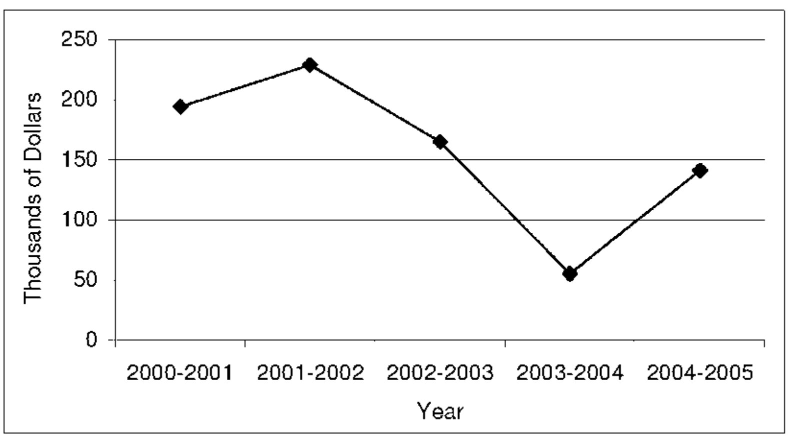
this reporting period was approximately $300,000. Training programs on how to apply those manuals are under development.

Erosion and Sediment Control: Erosion and sediment control program helps WSDOT keep runoff clean during construction projects. This is accomplished by, 1) training designers and builders, 2) providing design and contract standards, 3) inspecting construction projects, and 4) tracking water quality data collected during storms. Costs shown below do not include the actual costs to perform erosion control work in the field or to monitor water quality. Those costs are completely integrated with other construction costs and can't readily be tracked at this time. More detailed Erosion Control Program information is presented in section 4.

Is important to acknowledge that erosion control training costs decreased in recent years due to contractor training organizations that have agreed to teach WSDOT's erosion control curricula at no cost to WSDOT. For more information on these training programs see http://www.wsdot.wa.gov/environment/wqec/erosion.htm

Costs associated with developing erosion control planning and performance tracking tools are responsible for increased costs in the current reporting period.

Exhibit 2-4
Erosion Control Training, Inspections and Performance Tracking Costs



Stormwater permit Fees: WSDOT pays $33,000 per year in Municipal stormwater permit fees. Other permit fees are required for projects that could impact water quality. Total fee costs vary between $30,000 and $60,000 per year depending on the number of permits needed. In the current reporting period, WSDOT spent $40,000 in stormwater permit fees.

What are WSDOT's other stormwater management priorities?

Other important activities that were identified in the SWMP as medium or low priority are listed below. WSDOT continues to support these activities as resources allow. While WSDOT is actively working to address these issues the costs associated with them are not individually tracked.

- Supporting education programs,
- Determining maintenance requirements for treatment DMPs,
- Developing a statewide tracking system for treatment BMP construction,
- Identifying illicit discharges,
- Developing a tracking system for operations and maintenance activities,
- Monitoring operations and maintenance practices relative to water quality impacts, and
- Developing budgetary mechanisms to fund maintenance activities associated with water quality improvements.

Efforts related to education are described in Section 5.

Progress associated with all other priorities, which are maintenance-related is described in Section 3

What other WSDOT activities benefit water quality that are not stormwater permit requirements?

While not specifically established to reduce water quality impacts, the following programs benefit water quality by reducing the amount of pollutants that are generated or by preventing pollutants from entering stormwater.

Trip reduction program: This program keeps 19,000 cars off the road each day reducing emissions by 4,800 tons a year. As air pollution is a contributor to stormwater pollution, this

For more information on the benefits of the Commute Trip reduction program see http://www.wsdot.wa.gov/tdm/tripreduction/download/CTR_Report_03.pdf

program significantly benefits water quality. The program also reduces the need for additional highway construction.

Litter cleanup and the Adopt a Highway program: WSDOT spends $1.25 million to clean up 600 tons of litter each year. These programs prevent trash from entering our waterways as well as foster greater environmental awareness and a sense of stewardship among thousands of volunteers.

For more information on WSDOT's litter cleanup programs see http://www.wsdot.wa.gov/biz/adoptahwy/

Chapter 3 Maintenance and Operations

How do maintenance activities affect water quality?

Most maintenance activities simultaneously increase safety, extend roadway life and protect water quality. For example, cleaning drainage culverts prevents flooding that can damage highways and cause accidents. Cleaning culverts also prevents the debris in them from entering streams. Such maintenance activities are important components of WSDOT's overall program for protecting water quality.

Some essential maintenance activities are carefully controlled to avoid negative water quality impacts. Examples include the application of deicing materials and herbicides.

In accordance with the Stormwater Management Plan, WSDOT:

- Reports on highway sweeping activities and maintenance and repairs to BMPs.
- Estimates volumes of ice and snow control material, pesticides and fertilizers applied to roadsides and reports on research activities associated with those materials.
- Implements Integrated Vegetation Management Plans.
- Tracks and eliminates illicit discharges i.e., dumping of polluted water into our stormwater systems, and
- Tracks hazardous material spills.

What has happened in the current reporting period relating to these maintenance activities?

Road, drainage system and stormwater treatment BMP cleaning: As stormwater flows over pavement and road shoulders as well as through catch basins, culverts, ditches, ponds and vaults, it is important that these structures be cleaned. Cleaning these structures, 1) prevents accumulated sediments from entering state waters, 2) maximizes treatment system effectiveness, 3) prevents harmful roadway flooding, and 4) protects drivers by keeping road surfaces clean and safe. Exhibit 3-1 shows the costs associated with these cleaning activities.

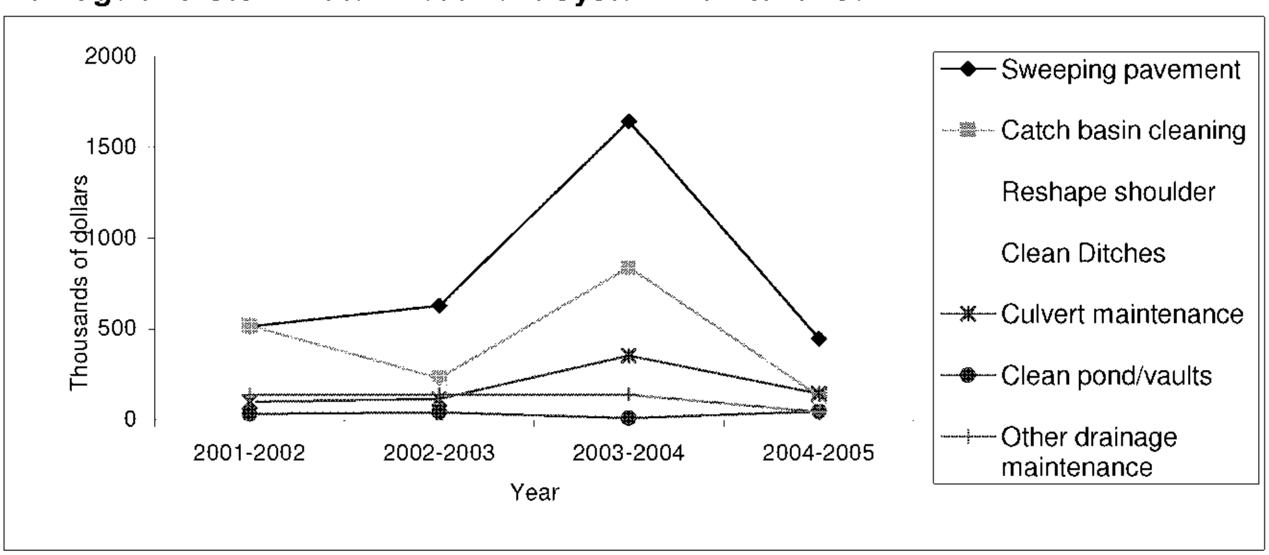
The most efficient means of keeping drainage systems clean and to ensure the effectiveness of stormwater treatment systems is to minimize the amount of sediment entering them. To that end, the bulk of cleaning costs are spent on sweeping road surfaces and cleaning out catch basins that trap sediment at the entrances of storm drains. These activities reduce the need to clean all other drainage and treatment structures. Even when road surfaces and catch basins are cleaned, road shoulders, ditches and culverts still need periodic cleaning to ensure optimal function. These activities, however, costs less.

WSDOT is working to develop better ways of measuring the water quality benefits of its maintenance activities. For example, in 2004 WSDOT started tracking the amount of street sweepings and vactor waste solids collected in Pierce County. Vactor waste solids consist of mud and dirt sucked out of catch basins, culverts and other underground structures. Sweeping and vactoring removed 580 cubic yards of solids that otherwise could have faulted stormwater drainage and treatment systems.

Exhibit 3-1 shows increased costs in 2003-2004. The increased costs are largely due to the unusually deep snowfall in the first week of 2004. As large amounts of sand were applied to keep major highways open, WSDOT had more material to clean off of the road and out of the drainage systems than normal.

Exhibit 3-1

Drainage and Stormwater Treatment System Maintenance



Ice and Snow: WSDOT belongs to a group of transportation agencies in northwest states and Canadian provinces known as the Pacific Northwest Snowfighters (PNS). One of their priorities is to develop anti-icing chemical specifications for use by all member organizations. These specifications require that anti-icing chemicals are environmentally safe. Several criteria must be met including heavy metal content and toxicity to fish before a chemical is considered for use. All current products used for winter maintenance meet these criteria. Exhibit 3-2 shows the quantities and costs of deicer materials used in the current reporting period. Exhibit 3-2 also shows the cost of sand cleanup activities and the amount of sand recovered.

Specifications created by the Pacific Northwest Snowfigthers help to standardize the market for anti-icing chemicals, resulting in better pricing and availability of more environmentally friendly de-icing chemicals.

Exhibit 3-2

Deicer Quantities Used in the Winter of 2004-2005 and Sand Cleanup Costs

De-Icer Material	Quantity	Cost
Sand	67,950 Tons	$583,445
Sand Cleanup	31,857 Tons	$1,093,060
Solid Deicer	15,307 Tons	$1,844,486
Liquid Deicer	3,312,474 Gallons	$2,375,387
Total Dollars Statewide		**$5,896,378**

Integrated Vegetation Management: WSDOT increasingly uses the Integrated Vegetated Management (IVM) approach to manage the vegetation that grows along highways. In accordance with the IVM approach, WSDOT controls undesirable roadside vegetation while establishing stable, low maintenance plant communities. This approach gradually improves the overall health of the roadside while reducing long-term maintenance costs and minimizing herbicide use.

For more information on WSDOT's Integrated Vegetation Management Program see http://www.wsdot.wa.gov/maintenance/vegetation/

Undesirable vegetation includes vegetation that spreads onto pavement and around roadside structures, noxious and nuisance weeds, and trees and brush that encroach on traffic operations.

Uncontrolled vegetation can quickly hide traffic signs, light poles, fog lines and guard rails, which are essential for protecting drivers.

Such plants create safety hazards, can damage the roadway and can create problems for surrounding land use and agriculture.

Noxious weed control is required by federal and local laws.

As vegetation varies greatly across the state, local IVM plans are being developed for each maintenance area. The plans require maintenance crews to take extra precautions for protecting water quality in sensitive locations.

When water sheets evenly off of the road pollutants are filtered out of the water in the grass. When vegetation encroaches on to the pavement, however, water can't drain evenly.

Areas covered by municipal stormwater permits will have completed IVM plans by spring of 2006. Plans will be implemented statewide by spring of 2007. WSDOT anticipates herbicide use will gradually decrease as plans are implemented.

Herbicide use is tracked by, (1 location and date, (2 herbicide used (by trade name), (3 total amount used, and (4 number of acres treated. Exhibit 3-3 is a summary of the acres of WSDOT property treated and quantities (pounds of active ingredient) used, by county for the 2004 calendar year.

Exhibit 3-3
Herbicides Use and the Number of Acres Treated in NPDES Permit Counties – 2004

County	Number of Products Used	Pounds of Active Ingredient Used	Acres Treated
Clark	16	944	577
King	18	1,702	2,444
Pierce	14	1,042	338
Snohomish	10	1,069	514

The pounds of herbicide used within the permit areas increased by 28% compared to the previous reporting period as weeds were controlled on more land. The amount of herbicide used per acre, however, decreased by 30% compared to the previous reporting period. Weed control in Clark County is largely responsible for the observed increase in herbicide use. As snow and ice control costs were lower than normal due to the mild winter, maintenance crews were able to control weeds much more aggressively than normal.

Statewide herbicide use is down 25% for the first half of 2005 compared to 2004. Continued declines in herbicide use are expected as WSDOT creates and implements IVM plans.

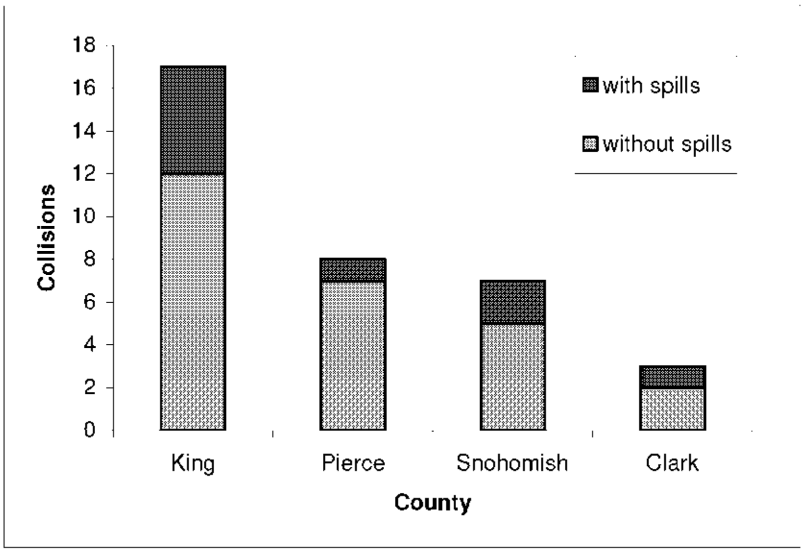
What are illicit discharges, why are they important and what does WSDOT do about them?

WSDOT does not permit adjacent landowners to dump untreated stormwater or polluted wastewater into WSDOT's stormwater system. Such dumping of polluted water is known as illicit discharges. As WSDOT's stormwater treatment systems are designed to treat runoff from highways only, such discharges can't be effectively treated. The producers of such runoff are responsible for preventing pollution or treating the water. Of the 1,329 previously unidentified stormwater outlets that were located during the current reporting period, 3 locations are suspected to be receiving water from illicit discharges. One location appears to receive untreated stormwater from an adjacent property; the second location appears to receive water tainted with farm animal wastes, and the third location appears to contain medical wastes. It is important that illicit discharges be eliminated. WSDOT will investigate these locations more closely to confirm whether or not they are impacted by illicit discharges. If it is determined that the suspect locations are impacted by illicit connections, WSDOT will take whatever steps it can to prevent the water from entering WSDOT's drainage system and notify the Department of Ecology.

Hazardous Material Spill Tracking: WSDOT tracks the number and location of collisions and spills involving hazardous materials. Data collected in the latter half of 2004 is presented in Exhibit 3-4, which includes a breakdown of collisions by county. Data for the first half of 2005 has not yet been compiled. Collision data is used to prioritize safety improvements that can help prevent future accidents.

Rear-end collisions caused seven of the nine hazardous materials spills. The high percentage of rear-end collision related spills suggests that practicing safe driving habits like allowing for adequate braking distance and giving trucks adequate space could eliminate the majority of collision-related spills.

Exhibit 3-4
Collisions Involving Hazardous Material Spills in Municipal Stormwater Permit Areas between July 1, 2004 and December 31, 2004



Whenever a collision results in a spill, WSDOT or the State Patrol notify Ecology's spill response crews who immediately go to the site, identify the spilled substance, determine how much was spilled, and direct cleanup activities as appropriate. Ecology's spill response crews have the expertise to accurately identify and measure spills, as well as the ability to document the effectiveness of cleanup activities. For this reason, detailed spill information is best tracked by the Department of Ecology.

Sensitive Area Mapping: To identify environmentally sensitive roadsides potentially impacted by maintenance activities, WSDOT has completed the marking and mapping of environmentally sensitive roadside areas. This mapping project identifies all sensitive area locations and provides

Sensitive area mapping is not a municipal stormwater permit requirement. As mapping streams, wetlands and other waters helps WSDOT better protect water quality, however, information on the program is included in this report.

guidance to WSDOT maintenance crews so that they can better protect streams, wetlands, and other water bodies.

Water quality is not the only environmental issue that maintenance crews must address. When it comes to protecting endangered runs of salmon and steelhead, however, protecting water quality is a major environmental concern.

Each maintenance area now has an atlas for their respective highway sections in which all sensitive areas within 300 feet of the roadway are identified. A Best Management Practice (BMP) Field Guide for Endangered Species Act (ESA) § 4(d) Habitat Protection (March 2004) has been developed and distributed to every maintenance worker and vehicle. The guide is intended for WSDOT maintenance crews and regional maintenance environmental coordinators who work within sensitive priority areas. The guide was developed to train and alert staff as to when and where special precautions must be taken to protect water quality, sensitive species habitats, and public safety.

Maintenance personnel report any discrepancies found in the field so that map quality can be continuously refined. These discrepancies are forwarded to a biologist for review and concurrence prior to updating data.

Chapter 4 Construction Site Erosion Control

Why is erosion control important on highway construction projects?

The movement of soil by water and wind is called erosion and bare soil can erode faster than soil covered with plants. As large highway construction projects expose and move large amounts of soil, they greatly increase the potential for erosion. Severe erosion increases the costs and time needed to complete highway construction projects. It also damages adjacent properties, makes our waters muddy, and hurts fish.

Historically, construction projects were a significant source of erosion. Proper erosion control, however, reduces construction site erosion by more than 95%.

What is the purpose of WSDOT's Erosion Control Program?

The purpose of WSDOT's Erosion Control Program is to minimize construction site erosion. Benefits of good erosion control include cleaner water, reduced construction costs and delays, and reduced risk of damage to adjacent properties. To continually improve erosion control performance WSDOT:

- Trains its designers, inspectors and construction contractors how to prevent erosion.
- Has specialists that can provide technical assistance to construction staff.
- Develops contracts to ensure that construction contractors provide effective erosion control.
- Performs statewide erosion control inspections.
- Monitors water quality at select high risk sites, and

- Notifies the Department of Ecology when problems occur so that their inspectors can provide additional support.

How does WSDOT prevent erosion?

Construction stormwater permits require WSDOT create Temporary Erosion and Sediment Control (TESC) plans. These plans establish when and where specific BMPs will be implemented to protect water quality. WSDOT has developed a program to ensure that quality TESC plans are consistently designed and implemented on construction projects.

Erosion control BMPs include structural devices like settling ponds, maintenance procedures like sweeping dirt off of roadways, and managerial practices like limiting major earthwork to the dry season. These BMPs are used in combination to prevent erosion or remove mud from water.

How does WSDOT prepare people to effectively prevent erosion?

All WSDOT design and construction staff who either write or implement TESC plans, and all contractors' designated Erosion and Sediment Control (ESC) Leads are required to attend WSDOT's *Construction Site Erosion and Sediment Control Certification Course* every three years. This course ensures that everyone with erosion control responsibilities knows the latest methods, products, and procedures for preventing erosion.

Construction contractor Erosion and Sediment Control leads are taught WSDOT–developed curricula by private contractor training organizations at no cost to WSDOT.

During the 2004-2005 reporting period, approximately 800 people attended the certification course; of which 256 were WSDOT employees. In the fall of 2004, when all major earthwork projects were inspected, it was determined that only one of the contractor's ESC leads wasn't certified. That contractor's ESC lead was required to attend training.

To ensure that the most effective, reliable erosion control products are used, new products are routinely evaluated. Products that meet WSDOT's specifications are added to a master list of approved materials called the Qualified Products List. Designers and builders can more quickly identify and buy quality products when they are on the list.

How does WSDOT ensure that adequate TESC plans are prepared?

Trained designers create plans that include all of the BMPs needed to prevent erosion. To ensure that all construction contractors are given clear guidance on how to implement the plan, WSDOT creates standardized instructions in contracts called Standard Specifications.

Other, more specific contract specifications are prepared for projects that require unique solutions.

WSDOT has designed a new web-based tool for creating TESC plans. This tool assists designers in preparing more complete and contractually enforceable plans by ensuring that all possible factors are considered and that adequate instructions are included in contracts. WSDOT also has erosion control specialists who help designers find solutions to unusually difficult challenges.

How does WSDOT verify that TESC plans are properly implemented?

Every fall WSDOT inspects all projects that pose moderate and high risks of erosion. In 2004, 12 projects were inspected to determine how well they were prepared for the rainy season. Preparedness was judged based on how thoroughly the contract specifications were implemented and, if large storms have already occurred, how effectively the plan prevented erosion. Whenever plan inadequacies were discovered, technical assistance was provided to ensure that the projects were fully prepared for wet weather.

How well is WSDOT doing and how can we do better?

The following table outlines how well WSDOT projects were prepared for rainstorms during the fall of 2004 compared to their level of preparation in 2002 and 2003. Performance for eleven of the fourteen TESC measures improved or remained stable at a high level. The biggest improvement was in protecting steep cut and fill slopes. Performance decreased for two measures, including a drop in how well the BMPs were maintained. In 2004, two new measures were added and one was modified to improve WSDOT's ability to track performance. Based on these results, WSDOT will focus its planning, contract enforcement, and training efforts to correct identified deficiencies, especially measures in the "Poor" and "Fair" categories.

Several performance measures in Exhibit 4-1 have been changed compared to the table in the 2004 report. As WSDOT's performance improves, performance measure are added, modified and eliminated based on their value in correctly identifying deficiencies and tracking improvements.

Exhibit 4-1

Erosion and Sediment Control Inspection Results.

		2002	2003	2004	Performance Status
Excellent	Delineate clearing limits	100%	100%	**100%**	stable
	Sediment control BMPs installed on time	90%	90%	**100%**	improved
	Control other pollutants from impacting water quality			**100%**	new measure
	Control flow rates	87%	84%	**100%**	improved
	Dewatering	100%	71%	**100%**	improved
Good	Access routes prevent tracking of mud onto streets	98%	69%	**91%**	improved
	Protect cut & fill slopes	67%	50%	**89%**	improved
	Storm drain inlet protection	74%	82%	**83%**	stable
Fair	Manage project erosion/sediment control BMPs proactively	56%	75%	**80%**	improved
	Channels for temporary stormwater conveyance are stabilized	90%	64%	**73%**	improved
Poor	Erosion control BMPs installed on time			**67%**	new measure
	Amount of disturbed soil covered with erosion control BMPs	65%	45%	**65%**	improved
	Site preparedness to resist erosion	86%	80%	**48%**	decreased*
	Maintain BMPs	70%	70%	**50%**	decreased

***In previous years, only the potential to discharge sediment to receiving water bodies was consider during assessments, which suggested a high level of performance. This measure was broadened in 2004 to include vulnerability to site damage, resulting in a perceived, but not real, decrease in performance.**

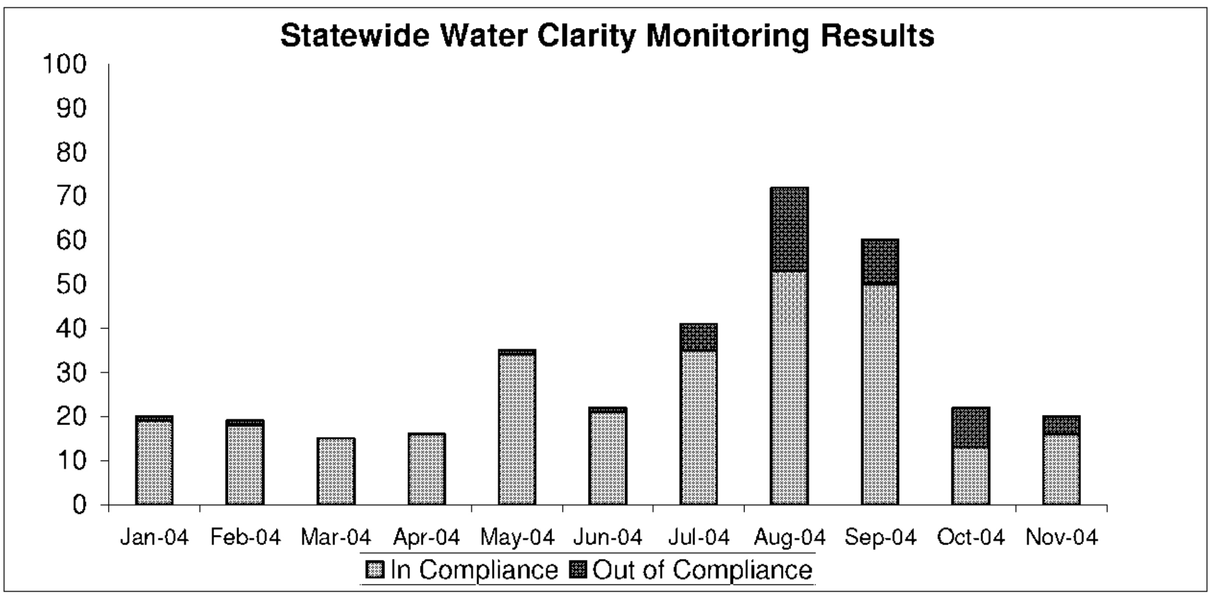
How well does WSDOT keep dirt out of water?

WSDOT completed its second year of construction site water quality sampling under a statewide monitoring policy that requires monitoring on at least 20% of all projects with substantial potential for water quality impacts. Samples are collected on projects during times when compliance with state standards is the most challenging, like during in-water work and during rainstorms.

In-water work includes any construction activity that occurs below the ordinary high water mark.

Exhibit 4-2 summarizes statewide monitoring results comparing water quality upstream and downstream from 13 projects. Eighty-five percent (290 out of 342) of the samples collected met water quality standards for water clarity. Of the 52 non-complying events, 37 were associated with permitted in-water work activities during the summer "fish window," which is the time of year when impacts to fish are minimized. The remaining events were associated with storms (8), muddy run-off from neighboring properties (5), or construction team mishaps (2). In all cases, monitoring results prompted corrective actions to restore compliance with water quality standards. WSDOT plans to improve compliance with water quality standards by eliminating deficiencies identified by the statewide inspections described above.

Exhibit 4-2
Statewide Water Quality Monitoring Results



How does WSDOT respond to erosion problems?

WSDOT has formal notification procedures called Environmental Compliance Assurance Procedures to ensure that water quality problems are properly recognized, reported to the Department of Ecology, and corrected to eliminate environmental permit violations. Any time WSDOT staff notice that water quality doesn't meet standards or any other environmental requirement is not met, they are required to notify both WSDOT management and Ecology.

Erosion control inspection results, water quality sampling data, and a summary of reported violations are published annually in WSDOT's performance tracking and reporting publication called the Gray Notebook. Results from the 2004 construction season are summarized on pages 64, 65, and 68 of the linked publication. http://www.wsdot.wa.gov/accountability/Archives/graynotebookDec-04.pdf

Chapter 5 Watershed–Based Treatment Approach Investigations

What is the watershed approach and when is it a better way to protect our states waters?

The watershed approach entails studying an entire watershed, identifying the overall needs of the watershed, identifying the best locations for addressing those needs, and providing stormwater treatment at the best locations in the watershed. Sometimes, much greater environmental protection can be provided using the watershed approach than by building stormwater treatment BMPs like ponds along side of highways. In urban areas where the highway is completely surrounded by buildings, there is no room to build ponds or other BMPs. Accordingly, WSDOT continues to participate in watershed-based planning programs, including working with other state agencies, local agencies, and planning groups.

The watershed approach allows a project proponent to look beyond the limits of the project itself in order to best address project impacts. Locations for stormwater treatment, for instance, can be selected that provide the greatest benefits to the entire watershed. Larger tracks of land away from the highway are often available where WSDOT can provide greater benefits, preserve open space, and provide valuable wildlife habitat at lower costs than WSDOT can

Presently, only flow can be addressed though a watershed approach. Water quality impacts still need to be addressed on-site. Watershed studies focus on identifying locations where the greatest environmental benefits can be achieved like preventing flooding, increasing groundwater recharge, and restoring healthy stream flow patterns. These locations often include previously drained wetlands, degraded stream buffers, cleared forest lands, and substandard stormwater facilities in older developments.

The watershed approach also minimizes impacts to humans. Land is $200 a square foot in downtown Seattle and highly populated. Taking that land to build stormwater BMPs is disruptive to communities and expensive.

The watershed evaluation process was tested on projects on SR 522 in Snohomish County, in North Renton on a segment of I-405, on parts of I-405 and SR 522 near Bellevue and Kirkland, and on SR 167 through the Kent/Auburn valley. The results of these characterization efforts are available for review at:

http://www.wsdot.wa.gov/environment/watershed/technical_report.htm.

The draft methodology was updated after each characterization project to reflect what had been learned in the characterizations. The methodology continues to generate interest from local governments, other state agencies, other states, and the federal government. The "Operational Draft Methodology" document is available at:

http://www.wsdot.wa.gov/environment/watershed/docs/methods.pdf

What other watershed related activities does WSDOT participate in?

WSDOT continues to participate on committees associated with the Salmon Recovery Act (ESHB 2496), the Watershed Management Act (ESHB 2514), non-point pollution (Clean Water Act Section 319) and numerous other state and local agency forums related to watershed governance and planning structures. WSDOT also continues to provide outreach and shares data with other watershed groups and planning entities when working on transportation projects.

Chapter 6 Stormwater Treatment Effectiveness Testing and Research

Why does WSDOT monitor the quality of stormwater runoff?

WSDOT is required by the Clean Water Act and Washington State Regulations to use "all known and reasonable methods of prevention, control and treatment" to protect our State's waters. When such steps are taken, it is presumed by regulatory agencies that WSDOT's runoff meets the State's Water Quality Standards. Considering the cost of treating stormwater, however, it is important to know how well required stormwater treatment facilities clean the water and that public funds are used in the most cost-effective manner possible. Water quality monitoring helps WSDOT answer the following questions:

- How effectively do WSDOT's stormwater treatment facilities remove pollutants?
- Which treatment approaches are most effective in a highway setting?
- What are the most cost-effective means of removing pollutants?
- How should WSDOT vary its treatment approaches for stormwater, given the highly variable nature of highways, climates and receiving streams?

Where and how does WSDOT sample stormwater?

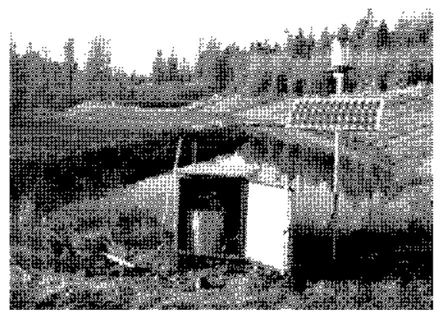
WSDOT collects stormwater samples at recently installed water quality treatment facilities that were designed in accordance with the latest design standards. These facilities may involve either engineered structural BMPs or landscape modifications to achieve treatment. Stormwater is sampled as

Composite sampling produces average results compared to discrete grab samples, which are snapshots in time. Grab sampling, however, is the only way to collect samples for some pollutants like oil. Likewise, grab sampling is sometimes the only feasible means of collecting samples in locations with low or unreliable flows.

it flows both into and out of stormwater treatment facilities to determine how effectively each facility removes pollutants and how clean the water is after treatment. These facilities are referred to as Best Management Practices (BMPs). It is important to note that BMP is a broader term that in other instances includes management practices that prevent pollution from occurring in the first place. Tested BMPs were built to 1995 design standards.

As the weather is often unpredictable, and stormwater quality varies throughout each storm, automated sampling devices are used in accordance with Federal Highway Administration guidance. The samplers are programmed to automatically collect samples in proportion to rainfall intensity or by the amount of water flowing through the BMP. The samples are combined to produce single "composite" samples that represent the average water quality during the storm. Following a storm, the samples are sent to a laboratory for analysis. Flow and rain data are also collected to characterize the rain event associated with each water quality sample.

An automated sampling device near a stormwater pond



Which pollutants are of most concern to WSDOT and why?

Past data collected by WSDOT along with data collected by other state transportation agencies indicate that the pollutants listed in Exhibit 6-1 warrant the most attention in highway runoff. State water quality standards and/or BMP performance goals exist for these pollutants, which sets clear objectives for treatment effectiveness.

Note: Theft and vandalism of equipment are making it increasingly difficult to monitor stormwater using automated sampling equipment. Despite escalating security measures taken by WSDOT, $10,000 worth of equipment was stolen or destroyed in the past two years.

Exhibit 6-1

Pollutants of Concern

Pollutant	Priority	Reason for level of concern	Major sources
Total Suspended Solids	High	Total Suspended Solids is a measure of all of the tiny bits of dirt and grime that are suspended in water. While not a regulated pollutant, such solids are a good indicator that other pollutants are present because many other pollutants attach to suspended solids. Accordingly, BMPs that reduce solids effectively reduce most other pollutants as well. The Department of Ecology has set an 80% removal efficiency of Total Suspended Solids as the performance goal for Basic Treatment.	Road wear, vehicles, deicing sands, erosion, and atmosphere (dust, leaves, pine needles, etc.)
Copper	High	Fish are highly sensitive to dissolved copper and the State water quality standards are set at very low concentrations. Untreated runoff from urban highways frequently exceeds standards and the effectiveness of required BMPs is highly variable because the copper concentrations are very low. To provide some perspective, the weight of dissolved copper that washes off of WSDOT's busiest highways before treatment is comparable to five pennies per acre each year.	Vehicle wear i.e. brakes, bearings, metal plating, engine parts
Zinc	High	There is more zinc in highway runoff than any other state-regulated metal. Untreated runoff from urban highways frequently exceeds standards and the effectiveness of required BMPs is variable.	Tire wear, corrosion of zinc-covered metals.
Oil and grease	Low	State law does not allow the discharge of pollutants that alter the color, taste or odor of water, which small amounts oil and grease can easily do. Likewise, increasing concentrations of oil and grease may suggest an increased likelihood that other, more harmful oil-based substances are present. Oil and grease are a low priority for WSDOT highways, however, because past sampling has shown that measurable quantities of oil and grease are rare, even on the most highly used highways. Oil and grease are more commonly observed in vehicle parking areas.	Vehicle lubricants
Phosphates	Low	Excessive phosphates can cause unwanted algae blooms in lakes. Phosphate concentrations in highway runoff are comparable to runoff from other land uses. All basic treatment facilities tested by WSDOT, however, surpass the performance goals set by Ecology.	Atmospheric deposition (i.e. dust, pine needles, leaves), fertilizers, eroded soils
Fecal coliform	Low	Fecal coliform indicates pollution with human and animal wastes that increase the potential for catching diseases.	Human and animal wastes. Sources include birds, and other wildlife, pets, sewage leaks to storms drains, etc.

What were WSDOT's monitoring objectives for 2004-2005?

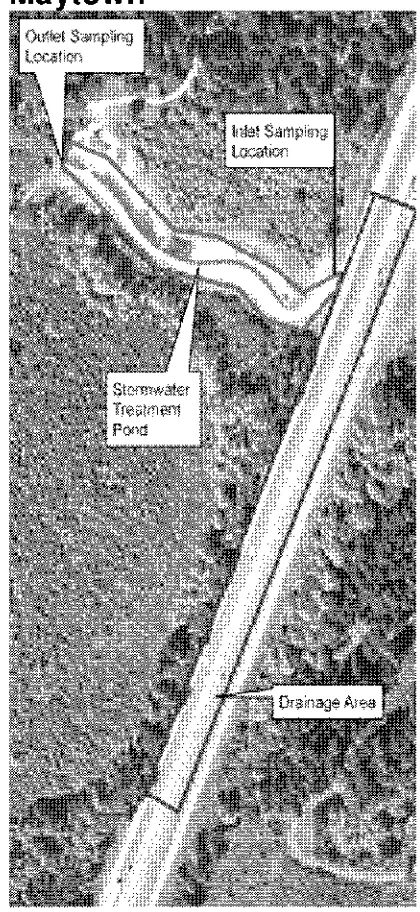
The focus of monitoring for this reporting period was to evaluate the effectiveness of BMPs at reducing concentrations of the pollutants described above (Exhibit 6-1) on highways with high and moderate traffic levels. Limited monitoring was also performed to start characterizing water quality along low traffic rural highways. Sampling was also initiated to determine the sources fecal coliform bacteria in highway runoff, and the effectiveness of BMPs at removing fecal pollution.

What sites were selected for treatment facility effectiveness monitoring in 2004-2005 and why?

Monitoring sites were selected to test the spectrum of treatment facility types ranging from vegetated shoulders and ditches to ponds and vaults constructed in accordance with the design criteria in WSDOT's 1995 Highway Runoff Manual. As in the previous reporting period, sampling locations were selected along high-traffic roadways i.e., having average daily traffic (ADT) of 90,000 to 160,000 vehicles and moderate-traffic highways (approximately 30,000 ADT). BMPs were monitored along high-traffic Interstate highways first to determine the quality of treated runoff in areas where pollutant loads are thought to be the highest. During this reporting period additional monitoring was initiated along a moderate-traffic state highway to determine the effectiveness of BMPs along WSDOT's more numerous local highways. Fecal coliform testing sites were also added in the winter and spring of 2005.

Criteria for selecting sampling sites included: 1) well defined drainage area that did not include water from adjacent properties, 2) accessibility and security for maintaining sampling equipment, 3) safety, and 4) proximity to offices with sampling staff and equipment. Narrow, low ADT highways were avoided at this time because past sampling efforts indicate that they infrequently produce enough runoff to collect samples. The selected sampling locations were located within the Snohomish County (Island-Snohomish permit area) and Thurston County. Whenever feasible, automated samplers were installed at the inlets and outlets of stormwater treatment BMPs. In cases where safety considerations prohibited sampling at the facility inlet, nearby reference sites were selected to represent untreated runoff. Monitoring site

Example of a monitoring location: Interstate 5 near Maytown



descriptions follow in Exhibit 6-2. Exact locations are not provided for security reasons.

Exhibit 6-2

Monitoring Locations

Treatment Facility type	Highway and nearest town	Traffic level (ADT)	Notes:
Wet pond – always contains some water	I-5, Maytown	90,000	The pond treats runoff from 8 acres of land including six lanes of traffic, highway shoulders and a grassy median. The water flows though a series of catch basins and pipes to the pond. The wet pond inlet was sampled to characterize the water before treatment and the outlet was sampled to determine the effectiveness of the BMP.
Wet pond - always contains some water	525, Mukilteo	30,000	The pond treats runoff from approximately 1.5 to 2 acres consisting of 4 lanes of traffic. The water flows through a series of catch basins and pipes to the pond inlet. The pond inlet was sampled to characterize the water before treatment and the outlet was sampled to determine the effectiveness of the BMP.
Vault - a buried concrete box	525, Mukilteo	30,000	The 3-chambered vault treats runoff from approximately 1.8 acres consisting of 4 lanes of traffic. The water flows through a series of catch basins to the vault inlet. The vault inlet was sampled to characterize the water before treatment and the outlet was sampled to determine the effectiveness of the BMP. The vault is located under the southbound shoulder of the highway.
Vault - a buried concrete box	405, Bothell	90,000	The vault treats runoff from approximately 1 acre consisting of 3 lanes of traffic, median, and road shoulder. Water from the roadway flows into a ditch, and via catch basins and pipes is conveyed to the vault under the median. Samples were collected from the vault outlet to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from the inlet to the vault Samples were also collected in 2003/2004.
Open vault – a concrete box with no lid	405, Bothell	90,000	The vault treats runoff from approximately 7 acres consisting of 6 lanes of traffic. Water is conveyed to the vault under the northbound highway shoulder. The BMP effectiveness samples were collected from the vault outlet pipe. Sample to characterize the water before treatment were collected at a catch basin located approximately 300 feet north of the vault.
Bioswale – a broad, grass lined channel	405, Bothell	90,000	The bioswale treats runoff from approximately 0.75 acres consisting of 3 lanes of traffic and a road shoulder. Water flows from the roadway into the bioswale. Samples were collected from the bioswale outlet to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from inflow to the closed wet vault located just north of the bioswale. Samples were also collected in 2003/2004.

Dry Pond – a pond that completely drains between storms	5, Everett	160,000	The pond treats runoff from approximately 3 acres of roadway and road shoulder. There are two inlets to the pond – one consists of a ditch conveying water from two lanes of southbound traffic and a road shoulder, while water from four lanes of northbound traffic and road shoulder is piped under the roadway into a vegetated ditch. Samples were collected from the pond outlet to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from the vegetated ditch that drains the four lanes of northbound Interstate 5 prior to entering the pond. Data was also collected in 2003/2004.
Dry pond - a pond that completely drains between storms	5, Lakewood	160,000	The pond treats runoff from 8 acres of roadway, median and road shoulder. Water is piped to a vault nearby that collects water until it is pumped to the pond. Samples were collected from the outflow pipe of the pond (although all water was infiltrated and no samples were collected) to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from the inflow pipe to the pond.
Unimproved Grass ditch (not a formal BMP)	525, Mukilteo	30,000	The ditch treats runoff from 1 acre consisting of two lanes of traffic and road shoulder. Water flows from the roadway into the 245-foot long ditch. Samples were collected at the end of the ditch to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected north of the BMP on State highway.
Unimproved Grass ditch (not a formal BMP)	405, Lynnwood	90,000	The ditch treats runoff from approximately 0.75 acre consisting of two lanes of traffic and the road shoulder. Water flows from the roadway into a 1,500-foot long ditch. Samples were collected at the end of the ditch to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected north of the BMP on State highway.
Ecology Embankment – a special road shoulder for filtering runoff	167, Auburn	96,000	The BMP treats runoff from approximately 0.5 acre consisting of two lanes of traffic and road shoulder. Water sheets off of the pavement into the 500-foot long embankment. Samples were collected from the embankment drainpipe to characterize the effectiveness of the BMP. Samples to characterize the water before treatment were collected from a nearby slot drain at the edge of pavement. Samples were also collected in 2003/2004.
Compost amended shoulder (Experimental)	5, Olympia	130,000	The BMP treats runoff from approximately 1 acre consisting of two lanes of traffic and a road shoulder. Water flows from the roadway through the compost-amended shoulder and ditch. Samples were collected at the end of the ditch to determine effectiveness of the BMP. Samples to characterize the water before treatment were collected just south of the BMP on Interstate 5. Samples were also collected in 2003/2004.

How does WSDOT ensure quality control?

WSDOT prepared a quality control plan called a Quality Assurance Project Plan (QAPP) (Tetra Tech 2003). QAPPs are required by the Department of Ecology to ensure that collected data meets quality standards so these data can be compared to data collected elsewhere. An addendum was prepared in 2004 (Tetra Tech 2004) to address added sampling locations along moderate-traffic highways and fecal coliform bacteria sampling. The QAPP is on file with the WSDOT's Water Quality Program. Samples collected from the referenced sites were analyzed for total suspended solids (TSS), hardness (see sidebar), total phosphorous, and for the dissolved and total forms of copper and zinc. In accordance with the referenced monitoring plan, grab samples were collected and analyzed for the presence of total petroleum hydrocarbons (TPH) when sheens were observed in the stormwater runoff at sampling sites. Grab samples were also collected and analyzed to determine fecal coliform bacteria concentrations.

Hardness is a measure of how much calcium and magnesium is present in water. Hardness is not a regulated parameter but it is needed to determine the water quality standards for metals like copper and zinc. Toxicity of metals decreases with increasing water hardness.

Study design for measuring BMP effectiveness: The study design requires collection of paired samples. Paired sampling means that BMP inflow and outflow samples are collected during a storm for comparison. This is necessary to measure how effective different BMP treatments are. There are challenges however, such as timing sample-collection with storms producing adequate flow, time lag between inflow and outflow, water infiltration from outside the test area, and equipment malfunction.

Recall that BMP (Best Management Practice) is actually a broader term that refers to both pollution prevention and pollution treatment. In this case BMP refers to treatment to remove pollutants from water.

What do the results tell us?

Data from several years of monitoring have been combined to show all BMP effectiveness data collected from 2002 through 2005. The data have been summarized in graphs so readers can quickly compare the quality of treated water to applicable water quality standards, and can view the effectiveness of different BMPs in relation to each other. The data are also presented in tabular form in Appendix 6-A. The original lab reports are several hundred pages thick, so they are kept on file at WSDOT and not included in this report.

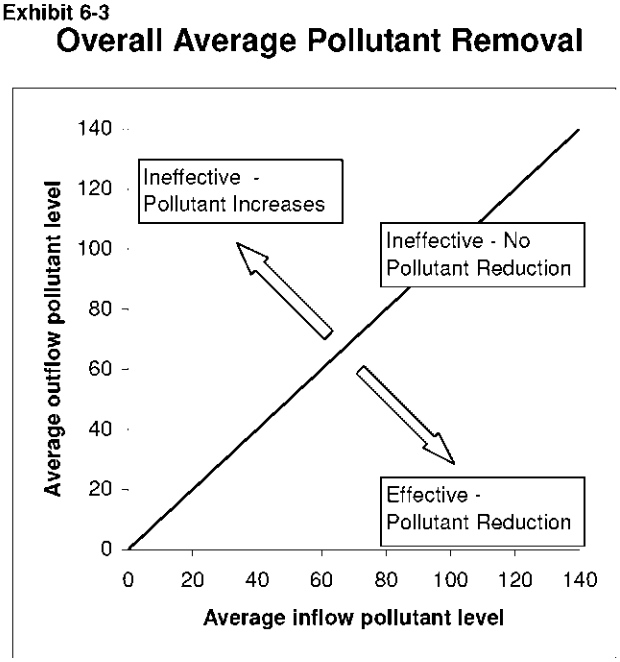
How to read the graphs: Exhibit 6-3 shows how to interpret the graphs, which follow. Each point on a graph represents stormwater pollution levels entering and leaving a BMP during a storm-event. The horizontal position of each point indicates how polluted water was before it was treated. The vertical position indicates the corresponding pollution level after the water was treated. For untreated (pre-BMP) water, the farther to the left a point is on the graph, the lower the pollutant level; the farther to the right, the higher the pollutant level. For the corresponding post-treatment pollution level, the closer the point is to the bottom of the graph the cleaner the water; the closer to the top, the higher the pollutant level.

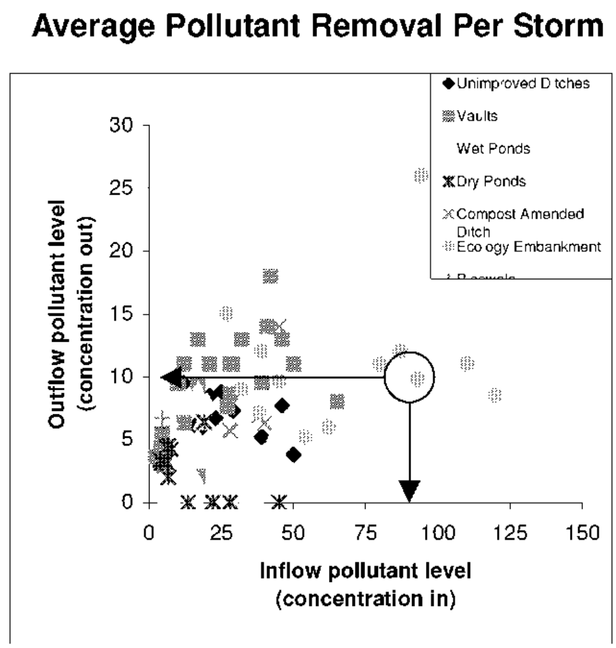
Explanations for why treatment BMPs may sometimes increase pollutant concentration include:

1. **Big storms can sometimes flush out accumulated pollutants.**
2. **Waterfowl wastes can increase nutrient and bacterial levels in ponds.**
3. **Plants release nutrients when they die.**
4. **Low pH (acidic) conditions can cause metals bound to soil to be released.**
5. **Organic soil amendments that usually trap phosphorus sometimes release soluble phosphorus as part of natural process that cycle nutrients through the environment**

Two graphs are presented for each pollutant. Each point on the first graph (left) represents the average of all data collected per BMP. The second graph shows paired (not averaged) data for the same pollutant to demonstrate variability. Each point on the second graph represents one paired sample.

Exhibit 6-3





These graphs show the overall effectiveness of different BMPs. For each BMP type, data from all storms are averaged for each facility. Horizontal and vertical (x and y) axes are the same scale. There is a 45-degree line, which represents no effect. Points, which fall along this line, indicate pollutant concentration did not change as water passed through the treatment facility. Points above the 45-degree line indicate that more pollutant left the facility than entered it (pollution increased). Points below the 45-degree line indicate pollutant decrease.

These paired-sample graphs illustrate treatment effectiveness of the different BMPs. Each point represents average treatment for one BMP during one storm. The horizontal and vertical (x and y) axes on these graphs are different scales to visually spread out all data points from all storms. Data for this example are for total copper, and units are micrograms per liter (*u*g/L). Note that the horizontal axis (concentration of pollutant before entering the BMP) goes from zero to 150 and the vertical axis (post-treatment concentration) goes from zero to 30, indicating a pattern of improvement. For the circled point, water going in at 93 *u*g/L came out at 9.8 *u*g/L.

Total Suspended Solids (TSS): Exhibit 6-4 shows the average TSS entering and exiting each type of monitored BMP. All BMPs are highly effective, removing between 95% and 98% of TSS, which exceeds the performance goal of 80% removal set by the Department of Ecology. As mentioned in Exhibit 6-1, when TSS is removed from the water many other pollutants that are attached to the sediment are removed as well.

Exhibit 6-4

Overall Average TSS Removal by BMP

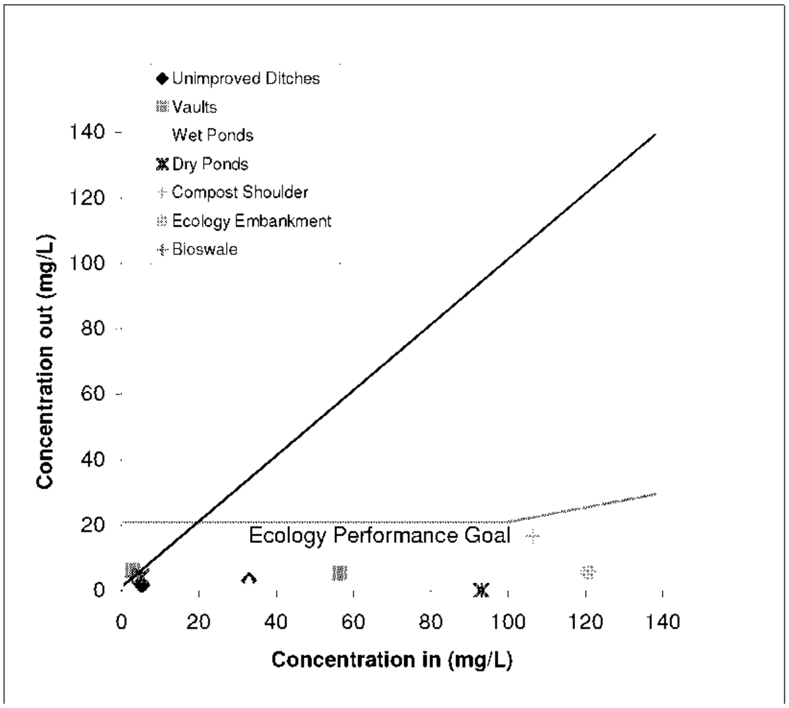
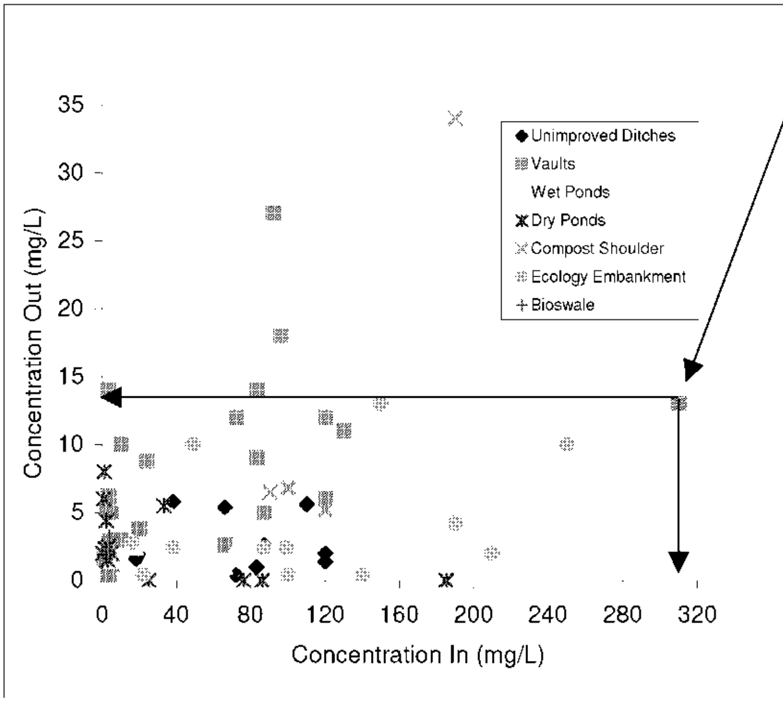


Exhibit 6-4 shows that all tested BMPs were effective at removing TSS. Very little TSS came out of any of the BMPs no matter how much went into them. For example, the average concentration of TSS entering the ecology embankment was 121 mg/L and the average concentration going out of the Ecology Embankment was 6 mg/L. Data points below the line representing the Department of Ecology's performance goal indicate that BMPs perform better than the goal.

It is important to note that even though TSS is the easiest pollutant to remove on a consistent basis, the quality of treated water is highly variable. All tested BMPs exceeded performance standards for TSS on average, yet performance was highly variable on a storm-by storm basis within a single BMP as well as among and between BMPs types. The variability is a result of many interacting factors including weather, drainage basin configuration, inflow concentration, etc. This variability makes it very difficult to guarantee compliance with standards during all storms or conclusively demonstrate one BMP type is better than another. To illustrate the variable nature of stormwater paired-sampling, event data for TSS is shown in Exhibit 6-5.

Exhibit 6-5

Average TSS Removal Per storm



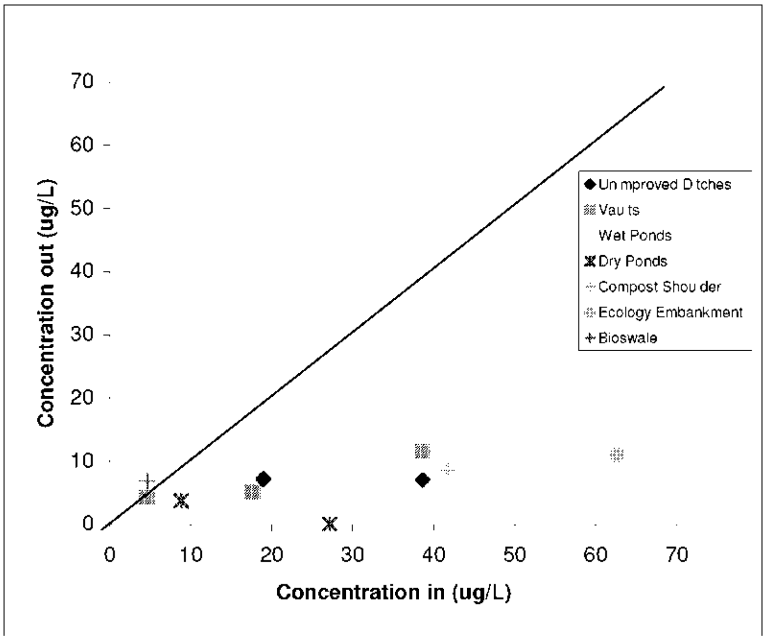
A single point represents each storm when paired data are plotted. The indicated point in Exhibit 6-5 graph represents a storm in which the TSS concentration was 310 mg/L going into a vault and 13 mg/L going out. The vault removed 96% of TSS during that storm.

The variability in Exhibit 6-5 is typical of stormwater. This variability makes it impossible to claim than any BMP can successfully clean the water all of the time. The variability also makes it difficult to compare BMP effectiveness.

Total Copper: Exhibit 6-6 shows that copper removal efficiency increases with increasing incoming copper concentrations. Tested BMPs removed larger fractions of total copper when incoming copper concentrations were high. Total copper consists of the copper particles that can settle out of the water and dissolved copper, which does not settle out of the water. Most of the copper that is removed as part of "total copper" is in the form of particles. Particles of metals are not toxic to aquatic life but dissolved metals are. Exhibit 6-7 shows that concentrations of total copper in treated runoff are highly variable but much lower than in untreated runoff. Ponds and ditches produced runoff with lowest copper concentrations. Vaults seem to be the least effective BMP for removing total copper.

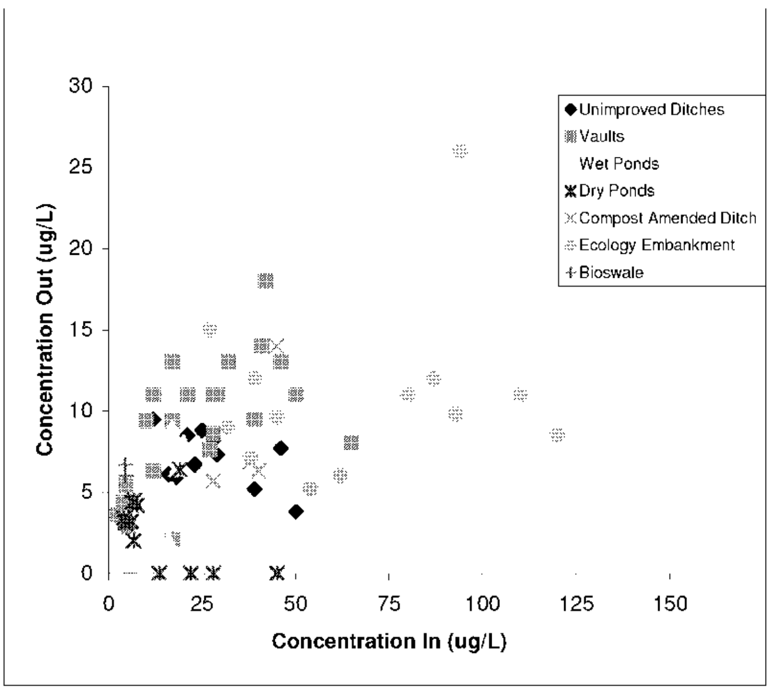
Removal efficiency rates are not always a good means of gauging BMP effectiveness. It is easier to remove most of the pollutants when water entering a BMP is really dirty. It is very difficult to remove even a small amount of pollutants when the water entering a BMP is fairly clean.

Exhibit 6-6
Overall Average Total Copper Removal by BMP



Total copper data reveals how variable the quality of untreated runoff is from place to place. Traffic levels at the bioswale and ecology embankment sites were nearly the same yet untreated water at the ecology embankment sites contained 16 times more copper. Pollutant removal efficiency increases with increasing incoming concentration, however, copper concentrations in treated water were similar.

Exhibit 6-7
Total Copper Removal per Storm



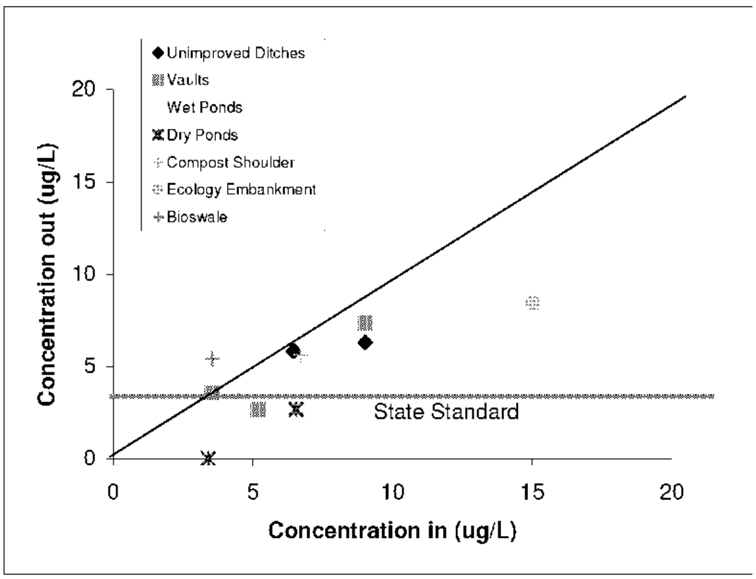
The numerous data points showing that no copper was discharged from wet ponds and dry ponds represent storms in which no water flowed through the pond outlets. All water was stored in the ponds and later evaporated or soaked into the ground.

Surface water standards for copper are 325 times more stringent than drinking water standards. Laboratory studies suggest that small concentrations of dissolved copper can cause nerve damage in fish.

Dissolved copper: It is much harder to remove dissolved than solid copper particles because dissolved copper must chemically bind to something before it can settle out of the water. Removing minute quantities of dissolved metal when the water chemistry constantly changes throughout and between storms is a big challenge. As no highly effective or reliable methods for removing dissolved metals have been identified at this time, the Department of Ecology has not established any numeric performance goals for the removal of dissolved metals. Exhibit 6-8 shows that available BMPs remove, on average, about a third of the dissolved copper. Treated stormwater meets dissolved copper standards for most receiving waters about 55% of the time.

Exhibit 6-8

Overall Average Dissolved Copper Removal by BMP



*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentration and in-stream water chemistry determine compliance in the receiving stream.

The better performance of wet and dry ponds is partially due to several storm events in which no water left the ponds. All water was stored and later soaked into the ground or evaporated. It is important to also note that grass ditches or bioswales precede the ponds. It is possible that the grass-lined channels add organic molecules to the water that bind with dissolved copper.

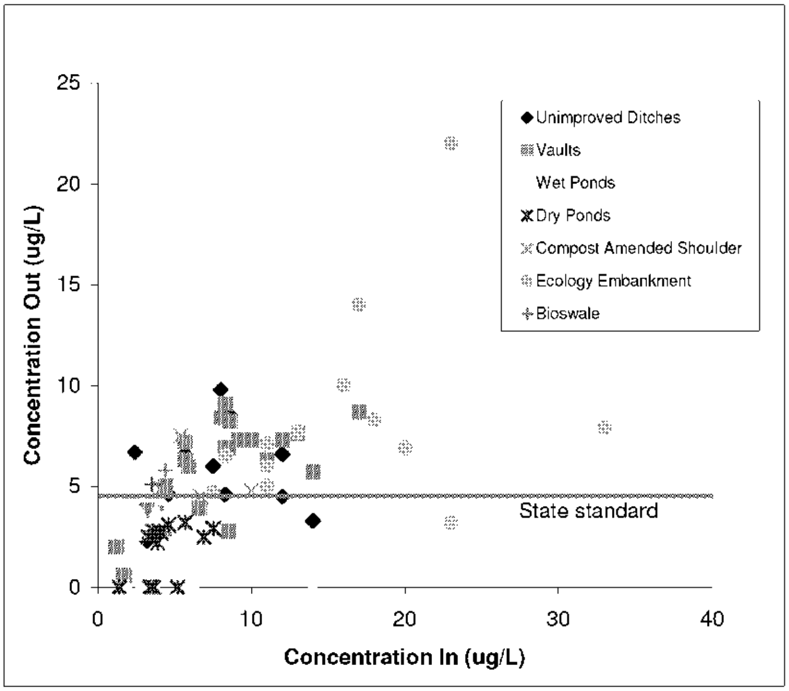
The paired sample data in Exhibit 6-9 indicates that BMP effectiveness in removing dissolved copper varies greatly between storms. When data are so variable it is difficult to claim that perceived differences are significant. It is also difficult to compare BMP effectiveness when the concentration

WSDOT data indicate that level of traffic isn't a reliable predictor of dissolved copper concentrations in runoff when traffic levels are between 30,000 and 160,00 ADT. The below data show that average concentrations of dissolved copper in untreated runoff vary widely rather than steadily increase with increasing traffic levels.

Highway/area	ADT	copper
525 Mukilteo	30,000	6.5 ug/L
525 Mukilteo	30,000	5.2 ug/L
405 Bothell	90,000	3.5 ug/L
405 Bothell	90,000	9.0 ug/L
5 Maytown	90,000	4.4 ug/L
167 Auburn	96,000	15.0 ug/L
5 Olympia	130,000	6.7 ug/L
5 Lakewood	160,000	3.4 ug/L
5 Everett	160,000	6.5 ug/L

of pollutants entering them is so variable. Wet ponds and dry ponds appear to be the most effective and vaults were the least effective.

Exhibit 6-9
Dissolved Copper Removal Per Storm



*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentrations and in-stream water chemistry determine compliance in the receiving stream.

Zinc: Exhibit 6-10 indicates that all of the tested BMPs did a good job of reducing total zinc concentrations when incoming concentrations were high. Total zinc consists of the particles that can settle out of the water and dissolved zinc, which does not settle out of the water. Most of the zinc that is removed as part of "total zinc" is in the form of particles. Paired samples indicate, however, that total zinc concentrations vary widely in treated samples.

Exhibit 6-10

Overall Average Total Zinc Removal by BMP

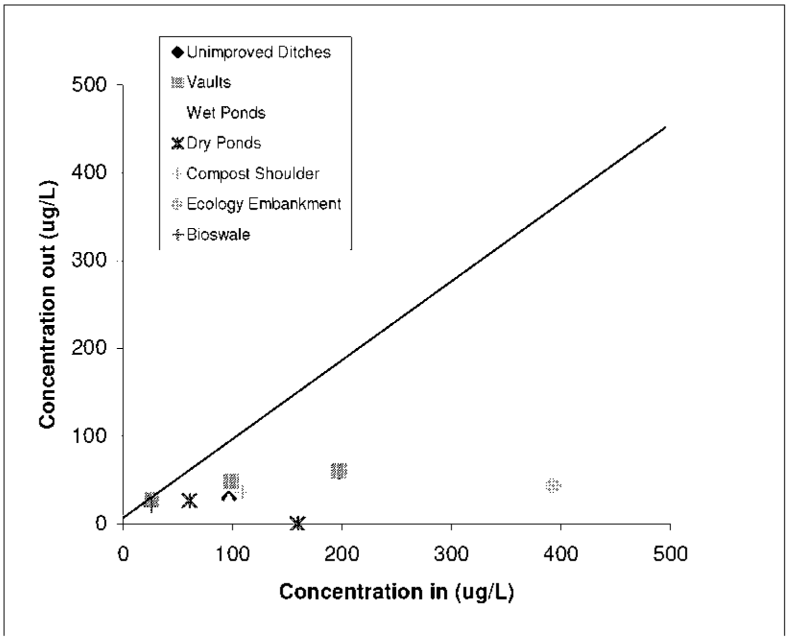
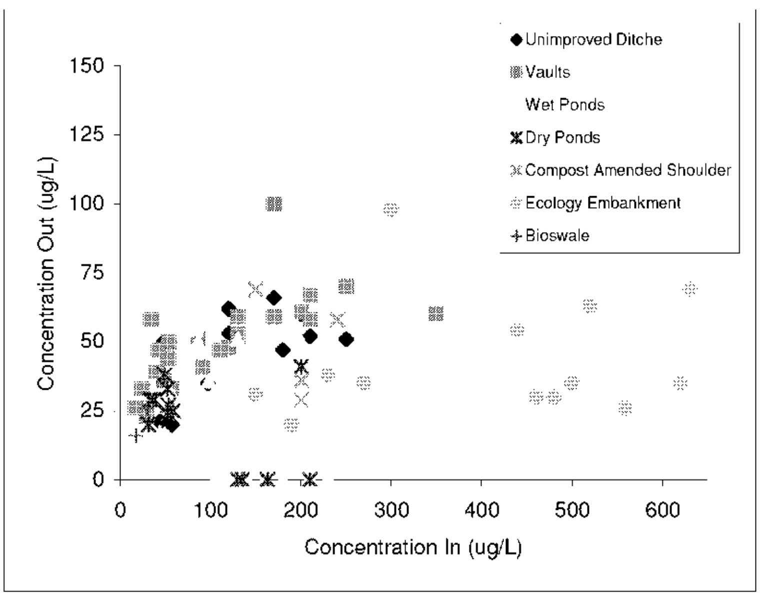


Exhibit 6-11

Total Zinc Removal by BMP Per Storm

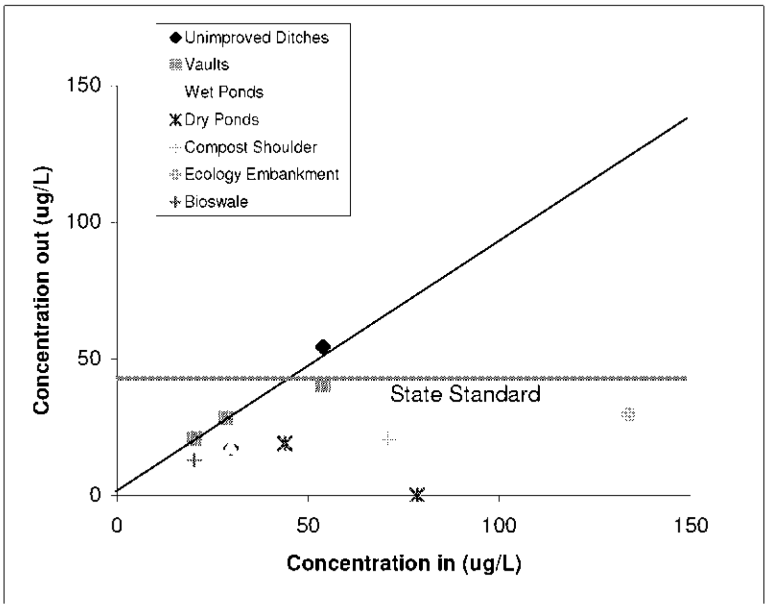


Exhibits 6-10 and 6-11 illustrate the potential problem of judging BMP effectiveness based on percent removal efficiency. The BMPs remove most of the zinc when incoming concentrations are high but can't remove zinc when incoming concentrations are low. They also illustrate the variability of untreated runoff.

Exhibit 6-12 shows that tested BMPs were more effective at removing dissolved zinc than they are at removing dissolved copper. The same challenges exist with removing dissolved zinc as exist for dissolved copper. Dissolved zinc, however, more readily binds to particles than does dissolved copper.

Treated water at the tested sites, met the receiving water state standards for dissolved zinc during about 80% of sampled storms.

Exhibit 6-12
Overall Average Dissolved Zinc Removal by BMP

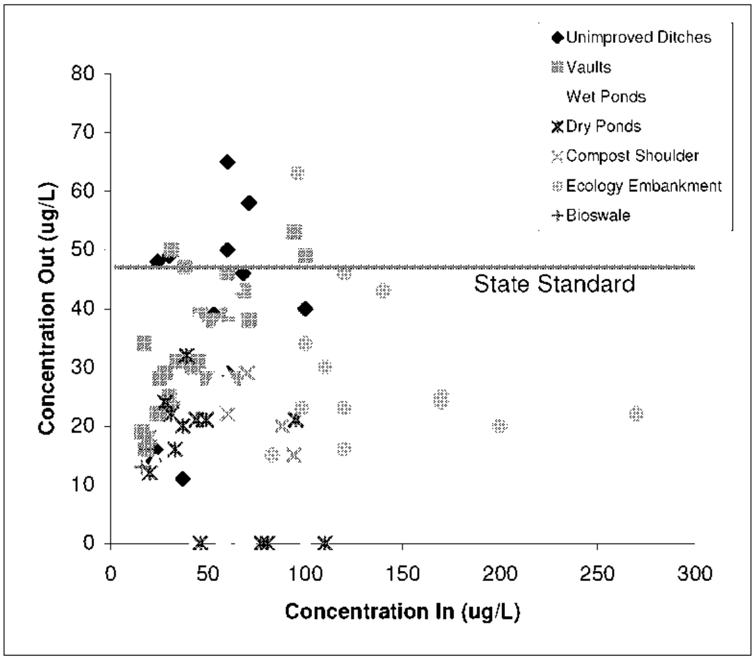


*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentrations and in-stream water chemistry determine compliance in the receiving stream.

Exhibit 6-13 shows paired data indicating that BMP effectiveness varies greatly between storms. The exhibit also shows that the ecology embankment effectively removes dissolved zinc even when zinc enters it at unusually high concentrations.

WSDOT data indicate that the concentration of dissolved zinc concentrations are not closely linked to traffic levels. The traffic levels at the bioswale and ecology embankment sites are similar yet pollutant concentrations vary dramatically.

Exhibit 6-13
Dissolved Zinc Removal Per Storm



*The State standard for receiving waters above is based on a typical hardness of 30 mg/L. Dilution, background concentrations and in-stream water chemistry determine compliance in the receiving stream.

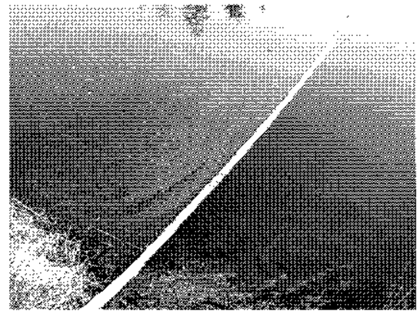
Oil Control: Stormwater is sampled for oil whenever oily sheens are observed. There is no numeric state water quality standard for oil but state water quality standards don't allow anything to adversely affect the aesthetics, smell or taste of water. To protect water from oily runoff the Department of Ecology has recently established triggers for requiring oil control treatment BMPs. The performance goal for oil control BMPs is "no ongoing or recurring visible sheen, and to have a 24- hour average Total Petroleum Hydrocarbon concentration no greater than 10 mg/L, and a maximum of 15 mg/L for a discrete sample." The oil control options in the Ecology Stormwater manuals include oil/water separators, sand filters and catch basin inserts.

As past sampling data indicate that numeric performance goals are consistently met when there is no visible sheen, WSDOT uses oil sheens as the trigger to perform oil control monitoring.

The new highway-relevant trigger for constructing oil control treatment BMPs is traffic exceeding 25,000 cars crossing 15,000 cars at lighted intersections. As oil-control BMPs have not yet been built at any such intersections, testing of BMPs at such locations isn't possible.

The only location where sheens were observed was the inlet to the Interstate 5, Maytown pond where WSDOT is testing an oil boom as more cost-effective, alternative oil treatment approach. Oil sheens were observed 9 times at the inlet before treatment. No sheens were observed at the outlet after treatment with the boom. The average and maximum concentration of oil in stormwater entering the pond was 3.3 mg/L and 18 mg/L. The average and maximum oil concentrations in stormwater after treatment with the boom were 0.9 mg/L and 4.2 mg/L. Boom effectiveness data have been submitted to the Department of Ecology so that booms can be considered as an additional treatment option.

Oil boom test site



All stormwater leaving the tested BMPs met the narrative standard of no visible sheen. As past data indicates that the numeric performance standards are met when sheens are not present, WSDOT is confident oil concentrations leaving its BMPs are lower than the post-oil treatment performance goals.

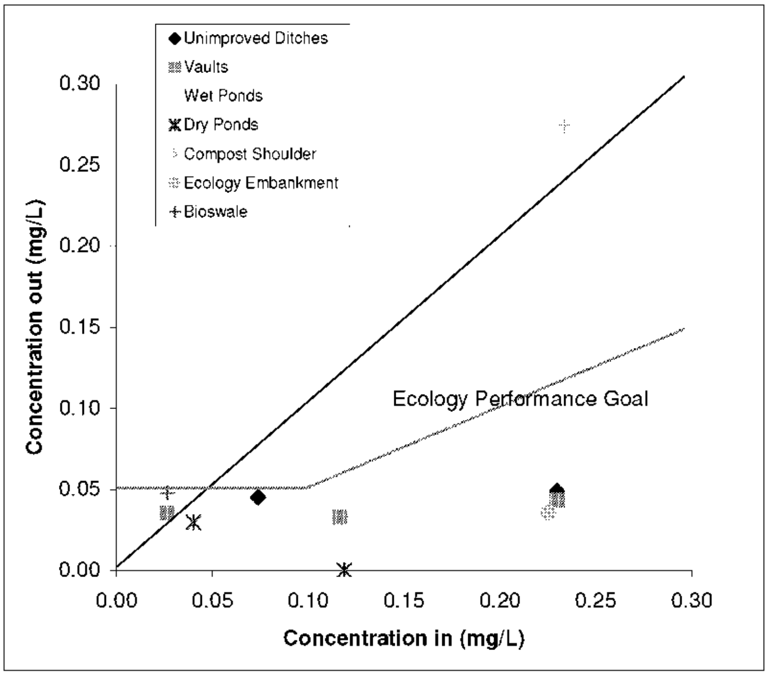
Most of the phosphorus in stormwater is attached to suspended particles. Because WSDOT's BMPs are highly effective at removing particles (TSS), they are also effective at removing total phosphorus.

Phosphorus: Small concentrations of phosphorus are present in runoff that can contribute to undesirable algae blooms in lakes. To protect lakes from algae blooms, Department of Ecology has established a special treatment facility menu for removing phosphorus in their stormwater treatment manuals. The treatment menu includes sand filters or combinations of BMPs. The performance goal for this special set of treatment options is 50% removal when the incoming concentration is between 0.1 and 0.5 mg/L.

The experimental compost shoulder slightly increased the concentration of phosphorus in runoff. It appears that dissolved phosphorus is released from the compost. The compost acted as a sponge, however, absorbing most of the water and allowing 2/3 of the stormwater to infiltrate locally. When infiltration is considered, the amount of phosphorus flowing off of the composted site was reduced by 54%.

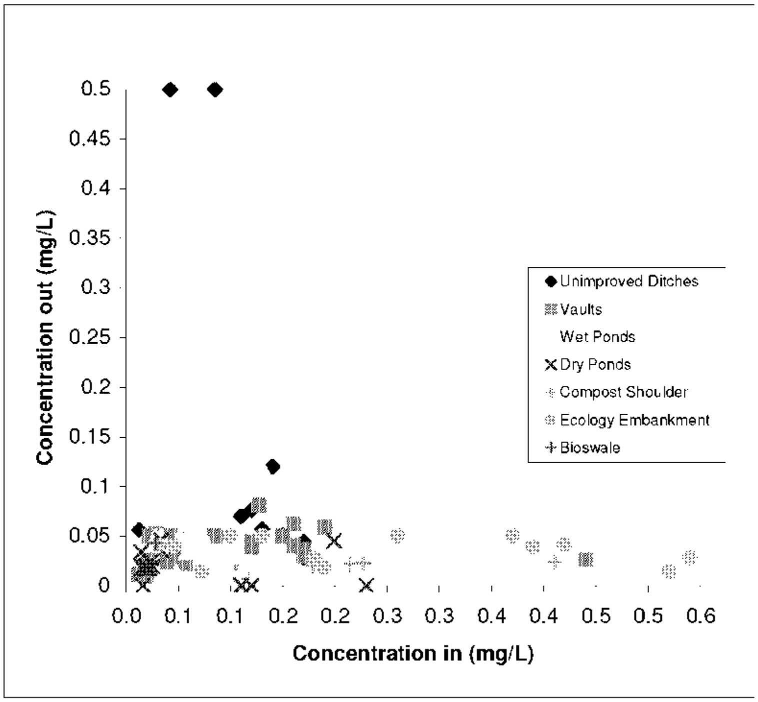
The tested BMPs, except for the compost shoulder (see sidebar), are all considered "basic treatment" BMPs and are not recognized in Ecology's stormwater manuals as adequate for meeting the phosphorus removal performance goal. Exhibit 6-14 shows, however, that these BMPs effectively remove phosphorus from runoff. The phosphorus removal efficiency of the tested "basic treatment" BMPs ranged between 73% and 92%, which is far better than the performance goal that Department of Ecology has established for the special, more expensive phosphorus treatment menu options.

Exhibit 6-14
Overall Average Total Phosphorus Removal by BMP



The paired data in Exhibit 6-15 show that nearly all treated water samples leaving all of the BMPs contained about the same concentration of phosphorus regardless of the concentration of phosphorus coming into them. The data show that there is an "irreducible minimum concentration" meaning a bottom concentration below which none of the BMPs can reliably remove phosphorus. An irreducible minimum concentration should be expected for phosphorus, as it is a nutrient that naturally cycles through the environment and can never be completely contained.

Exhibit 6-15
Total Phosphorus Removed Per Storm



Two exceptionally high phosphorus concentrations were observed in an unimproved ditch, which is not a recognized stormwater treatment BMP. Such variability is common in stormwater. The sources of variability are nearly infinite and often impossible to define for a given sample. Potential phosphorus sources include natural cycling of nutrients as they leach out of rotting vegetation, animal waste, road kill, a chemical or fertilizer spill, etc.

Fecal Coliform Bacteria:

Why is WSDOT monitoring fecal coliform bacteria in stormwater?

The Department of Ecology is preparing clean up plans to reduce the amount of fecal coliform bacteria (fecal coliform) in polluted waterways. These plans are supposed to identify and quantify the sources of fecal coliform. Once the sources are identified, management strategies and goals are set to eliminate or reduce the problem sources. While highways and cars don't produce fecal matter, concern has been expressed that fecal matter flows into and through highway stormwater systems

Fecal coliform is measured in colony forming units (cfu). Cfu's are measured by putting a water sample in a petri dish and later counting the number colonies of bacteria that grow on the gel.

before entering our State's waterways. In response to these concerns, WSDOT initiated limited fecal coliform sampling in this past reporting period. The purpose of this monitoring effort was to get some preliminary data to see how much fecal coliform is present in: 1) water flowing onto highway rights-of-way from adjacent properties, 2) untreated highway runoff, and 3) treated runoff. As fecal coliform is among the most variable of stormwater parameters, data presented in this section is not conclusive. Sample locations are described in Appendix 6-B and data are presented in tabular form in Appendix 6-C.

Ecology's stormwater management manuals don't address fecal coliform as a stormwater quality issue and do not set fecal coliform treatment performance goals. The state standard for fecal coliform, however, varies between 50 and 200 colony forming units (cfu)/ml depending on the class of receiving water. Stormwater from all land use types can exceed the water quality standards as a result of natural or human causes.

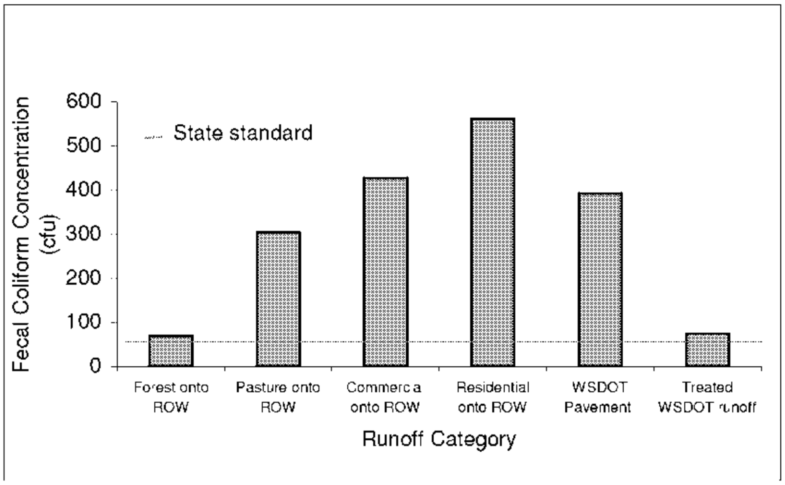
What land uses produced runoff with the most and least fecal coliform?

The highest concentrations of fecal coliform were observed in water running onto highway right-of-ways from residential areas. This observation isn't surprising in light of the Department of Ecology news release titled *Pooping Pets Pose Pollution Predicament* at http://www.ecy.wa.gov/news/2004news/2004-030.html, which estimates that pets produce 150 tons of waste each day in Washington. Runoff from commercial sites and pastures had fecal coliform concentrations that were comparable to untreated highway runoff.

While forests produced the cleanest water running into the highway right-of-way, 45% of samples from the forest exceeded standards.

Exhibit 6-16

Fecal coliform concentrations in water entering WSDOT rights-of-way, coming off WSDOT pavement, and after treatment.



Cars don't produce fecal matter, so how does fecal coliform get into highway runoff?

The two possible sources of fecal coliform in highway runoff are: 1) contaminated water flowing into the right of way, and 2) direct deposition of fecal matter onto the highway. Studies from around the country indicate that birds are a major, sometimes dominant, source of fecal coliform in stormwater (San Diego study). Other potential sources of fecal matter include other wildlife, pets, and sewage leaks that get into storm drains, etc. As WSDOT samples were collected from the road surface, birds, pets and other wildlife are suspected to be the dominant sources of fecal coliform in the collected samples. In locations where stormwater pipes are near leaky sewer pipes, fecal coliform can leak into stormwater pipes.

What can WSDOT do to reduce the amount of fecal coliform entering highway rights-of-way and stormwater?

If WSDOT observes that water entering the right-of-way is contaminated with sewage or animal wastes, WSDOT will notify the responsible landowner and the Department of Ecology so that the problem can be corrected.

WSDOT has no direct control over birds, other wildlife and pets. Pet owners can eliminate pets as a source by responsibly disposing of wastes. In some cases WSDOT can reduce the amount of bird waste entering stormwater by designing bridges, signs, and light posts in a way that they don't attract roosting birds. Likewise, the vegetation next to stormwater ponds can be managed to discourage pond use by waterfowl.

What can WSDOT do to reduce the amount of fecal coliform leaving its rights-of way?

While not specifically designed to remove fecal coliform, stormwater BMPs are very effective at reducing fecal coliform concentrations. The wet pond on highway 525 and the open vault on Highway 405 removed 98% and 85% of fecal coliform respectively. Likewise, two grass lined ditches removed 40% and 91% of fecal coliform. When measured, Low Impact Development BMPs which disperse, filter, and infiltrate runoff, are likely to vastly decrease discharges of fecal coliform bacteria during most storm events.

Very little stormwater data exists for rural highways as 1) pollutant concentrations are generally thought to be lower than on urban highways and 2) because rural highways are narrow and surrounded by undeveloped land, there is often a lot less runoff. Few municipalities are willing to risk wasting their stormwater monitoring funds by installing monitoring equipment in rural areas where there is a low chance of successfully collecting many samples.

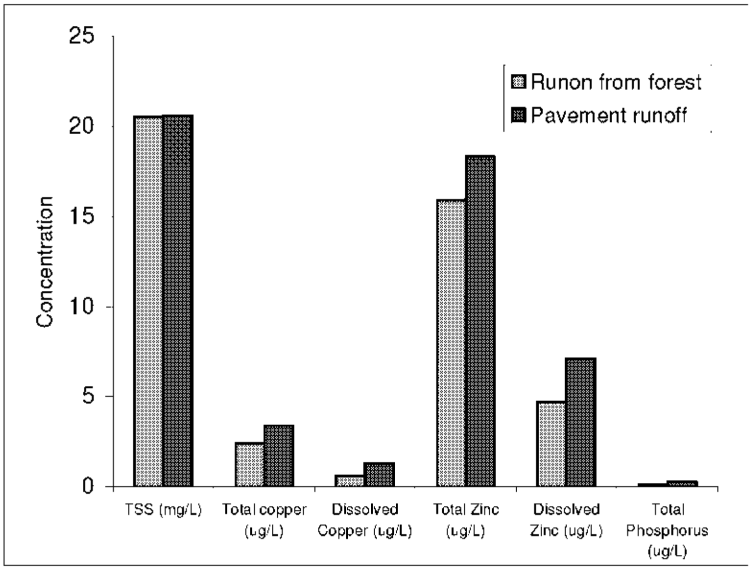
What is the runoff quality along low traffic, rural highways?

As the Department of Ecology is expanding the requirements to provide enhanced metals treatment to low traffic, rural highways, it is important that WSDOT collect water quality data for such highways. Flow-weighted composite sampling is not feasible for most rural highways because runoff usually sheets off of the highway and only sporadically trickles down ditches in such low quantities that the automated sampling devices can't be used.

Highway 121 is a rural highway with about 5,000 ADT in Thurston County. Stormwater grab sample results are shown in Exhibit 6-17. Data are presented in tabular form in Appendix 6-C. As grab sample data are highly variable, six grab samples were collected, results were combined, and average pollutant concentrations were calculated. Seven samples were also collected from ditches draining from an adjacent forest, to determine whether or not stormwater leaving the highway right-of-way was more polluted than natural background conditions in adjacent forests.

Exhibit 6-17

Pollutant Concentrations in Runoff Entering A Rural Highway Right-of-way in Thurston County Compared to Pavement runoff.



Caution should be used when interpreting data from limited sets of grab samples. Collected data from Highway 121 suggests, however, that rural highways runoff quality is very similar to runoff from undeveloped forest. Highway 121 data also suggests that, in at least this case, rural highway runoff is so clean that 1) water quality treatment BMPs might not be necessary to ensure compliance with water quality standards and that 2) BMPs would not make any difference.
Further investigation into the quality of rural highway runoff is needed to more accurately define treatment needs. WSDOT plans on sampling along more rural highways in the future using devices that can passively collect composite samples of sheet flow by letting a fraction of the water trickle into them throughout storms.

To estimate how widely average grab sampling results vary from average composite sampling results, 42 grab samples were collected at locations where automated composite samplers are used. Average grab sample concentrations ranged from between 17% lower to 122% higher than the average concentrations measured by automated sampling devices. The data suggests that grab sample results tend to provide higher, more conservative estimates of pollutant concentrations. Grab sampled data is included in Appendix 6-C.

Stormwater Research

Of the estimated $340,000 that was spent on stormwater research in the current reporting period (shown in Exhibit 6-18), some research projects span several reporting years. This research is answering important questions regarding:

- effectiveness of BMPs, especially Low Impact Development approaches,

- the proper sizing of BMPs based on climate and underlying soils,
- evaluating the economics of stormwater treatment i.e. cost-benefit, and
- pollutant source identification and source control.

Several of the studies have been completed and the data has been shared with Ecology for consideration for use in their stormwater management manuals. Research results are also expected to directly benefit WSDOT, as the data will help ensure that the properly sized, cost effective facilities are built.

Exhibit 6-18

Stormwater Research Project Status as of 6/30/2005

Project name	Description	Status
Compost Amended Vegetated Filter Strip	This project is quantifying the flow control and water quality benefits of composted shoulders, which is an approved Low Impact Development technique. The study is expected to help WSDOT and Ecology calibrate models for estimating how much water is detained or infiltrated. Secondary objectives include documenting how effectively compost removes sediment, metals, phosphorus and oil. This is a three-year project, largely funded by the Federal Highway Administration. Cost $345,000	One year completed in a three year study. Construction was completed in October of 2004. Data collection began immediately thereafter
Ultra Urban Stormwater Treatment testing (I-5 Ship canal Bridge)	The City of Tacoma is testing several BMPs for use in ultra urban settings where space is extremely limited at WSDOT's testing facility. WSDOT provides support as needed. Cost $30,000	Ongoing, a final report is expected in August 2006.
Runoff Treatment BMP Design in Cold Climates	This project will evaluate how BMPs should be designed in areas with cold climates where ice and snow can greatly influence BMP effectiveness. Cost $200,000	This is a two-year project that started in January of 2005.
Low Impact treatment methods – Natural Dispersion of Highway Runoff	This is a study by WSU to develop better sizing criteria for dispersion and infiltration facilities in eastern Washington Cost $125,000	Complete. Results were provided to Ecology and are now under consideration for use in updating Ecology's Eastern Washington Stormwater Management Manual.
BMPs for disposal of PCP grindings	This project evaluates the impacts of concrete grindings on pH and the use of compost to neutralize pH. Cost $10,000.	Draft report completed. Research indicates that compost greatly reduces the elevated pH levels.
Precipitation Modeling for Eastern Washington Stormwater design	This project will produce a map showing the expected rainfall amounts for the range of expected storm intensities across all of eastern Washington. This information will be used to more accurately size stormwater treatment facilities. Cost $85,000	Projected completion date October 2005
Floating Bridge Runoff Study	This limited study was performed in response to unusually high zinc concentration observed in runoff from a floating bridge. The study suggests that poor quality control in the downspout galvanization process in the 1960's is responsible for elevated zinc levels on one the bridges. Cost $20,000	Completed. WSDOT is evaluating how to prevent future problems with better quality control on materials.
Ecology Embankment	The Ecology Embankment is a Low Impact Development BMP that infiltrates and filters runoff within highway shoulders. Research started on this BMP prior to the development of Ecology's BMP testing protocols, which require dissolved copper data. Copper data was collected to document that this BMP meets the performance goal for Enhanced Metals Treatment.	Field Data collection completed and data has been submitted to Ecology.

Chapter 7 Stormwater Treatment Facility Construction and Retrofit

How important is stormwater treatment Facility Construction?
WSDOT considers permanent structural stormwater treatment BMPs to be its highest stormwater–related priority. As discussed in Section 6, stormwater BMPs remove pollutants and increase compliance with state water quality standards. Stormwater BMPs are built in tandem with highway construction projects and as stand-alone projects.

What triggers construction projects to include stormwater treatment BMPs?

Stormwater treatment facilities are required as a permit condition to treat runoff from new pavement whenever a roadway surface is expanded by 5,000 square feet or more, or when highways are substantially renovated. As specified and required under WSDOT's Highway Runoff Manual (WSDOT 2004) and the *Stormwater Management Manual for Western Washington* (Ecology 2001), WSDOT oversees the construction of permanent structural BMPs to treat runoff, for both water quality and quantity, coming off of the new surface or an equivalent area of nearby impervious surface.

How many and what kind of stormwater BMPs did WSDOT build in the past reporting period?

Exhibit 7-1 provides a summary of BMPs constructed within the general permit areas between July 2004 and June 2005. A description of each BMP type with milepost, offset direction, and facility size (where available) is provided in Appendix 7-A.

Exhibit 7-1

Stormwater Facilities Built Within the NPDES Permit Areas Between July 1, 2004 and June 30, 2005

Project Designation	Number and Type of Structural BMPs Constructed			
	Open Water Detention (1)	Detention Vaults (2)	Infiltration BMP (3)	Linear Treatments (4)
SR 16, Burley-Olalla Intersection	1			3
SR 166, Ross Point Vicinity Slide Repair				1
SR 167, North Sumner Interchange	1		1	3
SR 104, Jct. SR 19 Intersection Safety				1
I-5, SR 501 Ramp Signals			1	1
SR 14, 32rd Street Intersection Improvements				1
SR 203, NE Stillwater Hill Rd & Fay Rd Channelization		1		
SR 405, SE 8th Street Interchange Modifications	1	1		1
SR 405, NE 8th Street Undercrossing	2			
I-5, 196th Street SW/SR 524 Interchange	3			2
SR 9, SR 96 Vicinity to SR 204 Vicinity Paving				2
SR 525, Cameron Road to SR 20	4			11
Totals	**12**	**2**	**2**	**26**

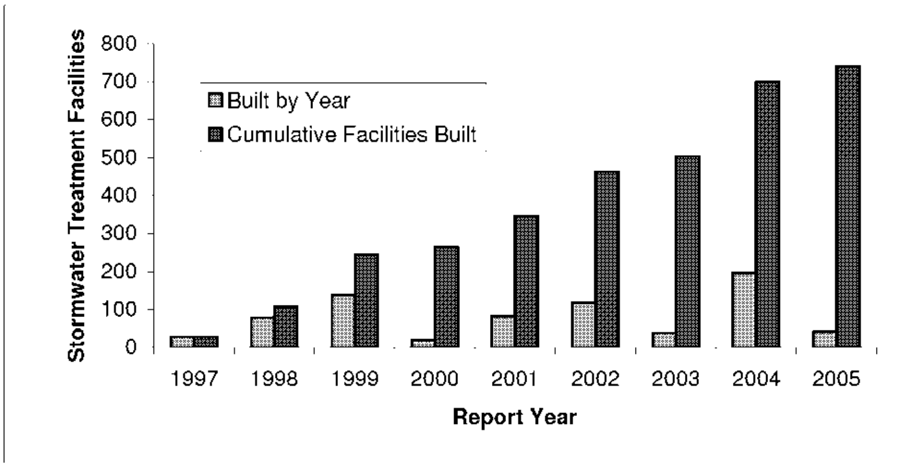
(1) Open water detention includes detention ponds and wet and dry ponds.
(2) Detention vaults include wet vaults and detention pipes.
(3) Infiltration BMPs include infiltration ponds and natural dispersion.
(4) Linear treatments include biofiltration swales, Ecology Embankments and vegetative filter strips.

How many BMPs has WSDOT built in the permit areas since the permits were issued?

Exhibit 7-2 shows that WSDOT has built 741 stormwater treatment BMPs in the four counties tracked for permit reporting purposes since 1996. While the number of treatment facilities construction varies greatly from year to year due to fluctuating construction budgets and the timing of projects, WSDOT is steadily increasing the number of stormwater treatment facilities to treat highway runoff.

Exhibit 7-2

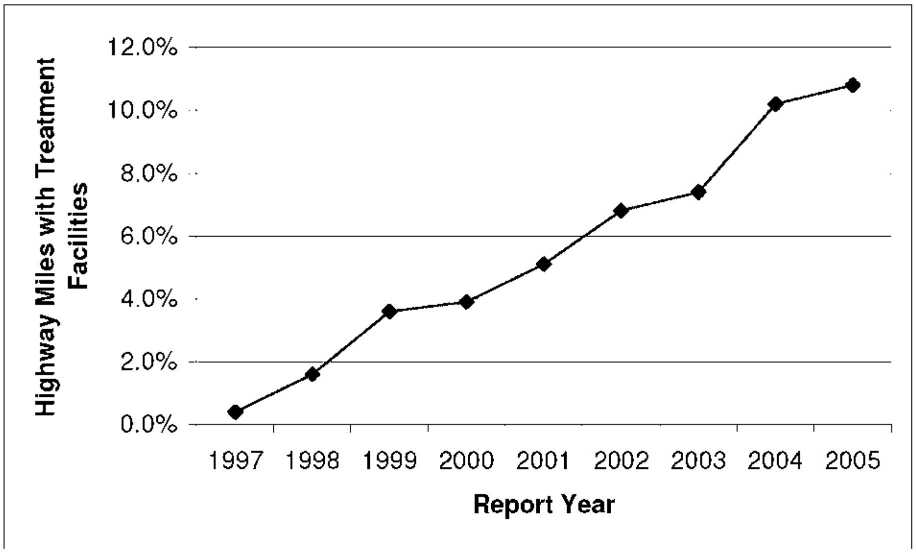
Number of Stormwater Treatment BMPs Built in the Four Stormwater Permit Counties (King, Pierce, Snohomish, and Clark) Since 1996.



To put the number of new facilities constructed in the permit areas in context, the number of new facilities was compared to the estimated number of facilities that would be required to treat all 1,140 miles of highway within the four counties. If an average of 6 facilities are required for each mile of highway, WSDOT is providing new facilities for an estimated 1.1% of highways in those counties each year.

Exhibit 7-3

Estimated Percent of Highway Miles in Four Counties (King, Pierce, Snohomish, and Clark) With New Stormwater Treatment Facilities Built Since 1996.



It is important to note that new highway construction projects primarily treat the new road surfaces. While stormwater facilities are often sized to treat some or even all of the existing highway surfaces in the construction project area, construction projects generally don't treat all runoff from all highway surfaces. Stand-alone stormwater treatment facility construction projects are required to provide treatment in the remaining areas.

What is WSDOT's Stormwater Inventory and Retrofit Program and why is it important?

As discussed above, new highway construction projects include ponds and other stormwater BMPs built in accordance with standards. Prior to modern water quality regulations highways were built without any consideration for water quality. Accordingly, most of WSDOT's older surfaces have no facilities to hold back the stormwater and remove pollutants before letting the water enter streams or other sensitive waters. The discrete locations where water leaves highway property are called "outfalls". Luckily, in some locations the water is passively treated by roadside vegetation and soils. Many of the older sites lacking treatment facilities are undoubtedly letting more pollutants enter our waters than newer sites. Such outfalls are having a larger impact on our waters than they should and need to be fixed or "retrofitted". Retrofitting outfalls is accomplished by building ponds and other treatment facilities to remove pollutants before water gets to the outfall.

Stormwater outfalls are places where flowing water leaves the highway and enters 1) streams, lakes, wetlands or any other natural water, 2) a local storm drain system, or 3) groundwater. It is estimated that WSDOT has between 18,000 and 24,000 stormwater outfalls.

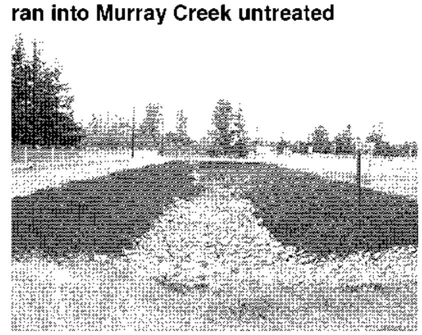
Before WSDOT can retrofit the thousands of old outfalls that have no treatment facilities, WSDOT must first inventory and prioritize them. Inventorying outfalls consists of 1) identifying how many outfalls WSDOT has and where they are located, 2) estimating the impacts of each outfall so that they can be prioritized for retrofit, and 3) identifying the proper treatment facilities to correct problems at each location. As WSDOT does not have the resources to retrofit all of the deficient outfalls at once, the outfalls are prioritized so that the largest problems are solved first.

Inventorying, prioritizing and retrofitting the outfalls that have been built over nearly a century is a big task that will require significant resources and time to correct. Nevertheless, WSDOT has made significant steps during this reporting period.

Scoping entails developing a preliminary design and budget for a potential project so that it can be considered for funding.

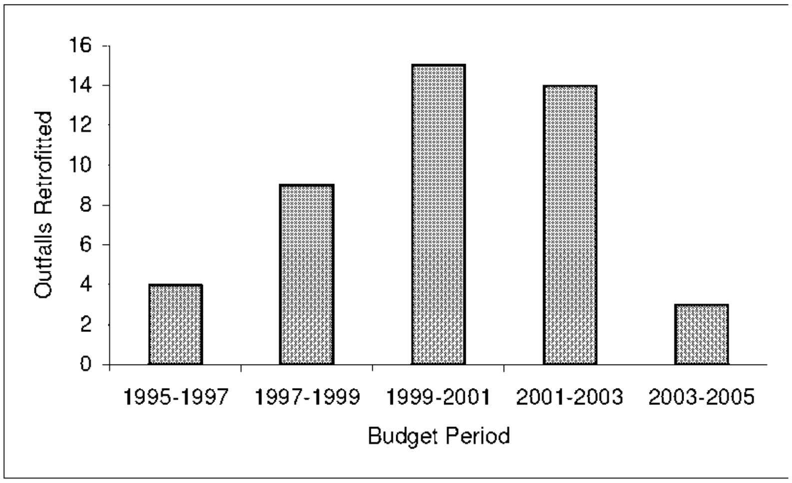
- The locations of 1,240 outfalls have been added to the inventory database in western Washington.
- Sufficient data has been collected to prioritize and identify retrofit solutions for 275 outfalls. The total number of outfalls that have been prioritized is 1178.
- 6 additional potential projects were scoped with the potential to retrofit 31 outfalls
- 7 scoped projects were funded by the legislature that may retrofit up to 46 stormwater outfalls.
- $249,000 was spent on a high-priority stand-alone stormwater retrofit project along I-5 in this reporting period. Additionally, 2 outfalls were retrofitted in Vancouver, by a local utility district using stormwater utility fees

This pond was constructed as a retrofit project in 2004. It treats water from 8 acres of I-5 to protect Murray Creek and American Lake. The site was monitored for a year. All stormwater filtered through the compost and soaked into the ground. Prior to the project, water ran into Murray Creek untreated



With the work completed in the past reporting periods, an estimated 22-29% of WSDOT's outfalls have been identified and 4.9-6.5% have been prioritized for retrofit. Exhibit 4-4 shows that forty-five outfalls have been retrofitted as stand-alone projects since 1995. A one-time increase in funding during the 1999-2001-budget period was responsible for the elevated retrofit rate between 1999 and 2003.

Exhibit 7-4
Outfalls Retrofitted as Stand-Alone Projects



For the next reporting period, WSDOT intends to inventory and prioritize more outfalls within the permit areas, contingent upon available funding.

Inventorying efforts have been expanded to include data collection by WSDOT Maintenance staff. In association with their regular activities, data is collected to help populate the Stormwater Database. Also, outfalls and existing BMPs will be inventoried as part of WSDOT's new Roadside Features Inventory Program.

Planned changes to the database for the next reporting period include expanding the database to accommodate the forthcoming revisions to the Underground Injection Control rule. The Underground Injection Control rule (WAC 173-218) is intended to protect groundwater supplies by regulating "injection" of potentially polluted water into the ground. Some of WSDOT's stormwater infiltration facilities will be regulated under the new rule.

Chapter 8 Certifications

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

MUNICIPAL STORMWATER PERMIT PROGRAM

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for willful violations.

Megan White 9/2?/16

Megan White, P.E. Date

Environmental Services Office Director

Washington State Department of Transportation

Chapter 9 References

Tetra Tech, Inc. 2003. Sampling and Analysis Plan, WSDOT Stormwater Characterization/Water quality Management Effectiveness Monitoring 2003/2005 Sampling Season. Prepared for the Washington State Department of Transportation Environmental Services Office. October 2003.

Tetra Tech, Inc. 2004. Addendum to Sampling and Analysis Plan, WSDOT Stormwater Characterization/Water quality Management Effectiveness Monitoring 2003/2005 Sampling Season. Prepared for the Washington State Department of Transportation Environmental Services Office. October 2004.

Washington State Department of Ecology. 2001. Stormwater Management Manual for Western Washington. Washington State Department of Ecology Water Quality Program. Publication Numbers 99-11 through 99-15. August 2001.

WSDOT. 1997(a). Washington State Department of Transportation Stormwater Management Plan for the Island-Snohomish, Cedar-Green, and South Puget Sound NPDES Municipal Separate Storm Sewer System Permit Areas of Washington State. 25 March 1997.

WSDOT. 2004. Washington State Department of Transportation Highway Runoff Manual No. M 31-16. Prepared by Washington State Department of Transportation Environmental and Engineering Service Center. March 2004.

Appendix 6-A Stormwater Treatment Facility Effectiveness Data

NS means no sample was collected
TP stands for Total Phosphorus
HA stands for Hardness
TSS stands for Total Suspended Solids
Values in grey represent No Detection and are reported as half the detection limit.

Untreated Runoff

Wet Pond I-5 MP 96

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/17/03	0.070	12.0	7.4	86	3.6	64	18.0
11/25/03	0.130	49.0	20.0	130	3.9	64	16.0
11/28/03	0.077	42.0	17.0	84	4.2	44	10.0
12/5/03	0.116	72.0	17.0	130	3.5	61	25.0
12/13/03	0.081	47.0	14.0	98	2.8	57	15.0
1/23/04	0.123	37.0	18.0	140	5.0	63	50.0
1/28/04	0.240	160.0	42.0	180	3.5	54	28.0
3/5/04	0.177	88.0	29.0	180	5.6	72	37.0
3/19/04	0.090	110.0	38.0	230	14.0	100	43.0
3/24/04	0.230	81.0	27.0	160	5.6	59	27.0
9/11/04	0.041	29.0	9.0	105	3.7	71	16.5
10/8/04	0.089	66.0	24.0	140	6.3	68	25.0
10/30/04	0.067	56.0	13.5	115	2.8	57	25.0
11/2/04	0.108	67.0	17.0	125	3.0	59	23.0
11/18/04	0.220	240.0	36.0	210	3.6	66	28.0
11/26/04	0.057	73.0	16.5	105	2.2	56	14.0
12/9/04	0.160	130.0	35.0	200	3.8	86	38.0
1/17/05	0.220	200.0	33.0	180	1.9	43	18.0
Samples	18	18	18	18	18	18	18
Maximum	0.240	240.0	42.0	230	14.0	100	50.0
Minimum	0.041	12.0	7.4	84	1.9	43	10.0
Mean	0.128	86.6	23.0	144	4.4	64	25.4

Treated Runoff

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/17/03	0.005	6.0	6.6	50	4.7	41	21.0
11/25/03	0.120	4.0	8.1	74	3.6	44	23.0
11/28/03	0.022	3.8	9.0	55	3.4	38	24.0
12/5/03	0.022	2.5	5.2	51	2.7	36	23.0
12/13/03	0.020	2.0	4.8	36	3.6	30	27.0
1/23/04	0.024	4.0	6.4	66	3.8	40	41.0
1/28/04	0.023	1.2	4.8	38	3.2	28	36.0
9/11/04	NS	NS	NS	NS	NS	NS	NS
10/8/04	NS	NS	NS	NS	NS	NS	NS
10/22/04	NS	NS	NS	NS	NS	NS	NS
10/25/04	NS	NS	NS	NS	NS	NS	NS
10/30/04	NS	NS	NS	NS	NS	NS	NS
11/2/04	NS	NS	NS	NS	NS	NS	NS
11/10/04	NS	NS	NS	NS	NS	NS	NS
11/18/04	NS	NS	NS	NS	NS	NS	NS
11/26/04	0.034	14.0	8.0	60	4.3	37	22.0
12/4/04	NS	NS	NS	NS	NS	NS	NS
12/9/04	0.019	2.8	7.7	50	3.8	33	27.0
12/13/04	NS	NS	NS	NS	NS	NS	NS
1/7/05	NS	NS	NS	NS	NS	NS	NS
1/17/05	NS	NS	NS	NS	NS	NS	NS
1/18/05	0.063	18.0	9.8	66	2.6	37	23.0
Samples	10	10	10	10	10	10	10
Maximum	0.120	18.0	9.8	74	4.7	44	41.0
Minimum	0.005	1.2	4.8	36	2.6	28	21.0
Mean	0.035	5.8	7.0	55	3.6	36	26.7

Wet Pond SR 525 MP 3.3

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/1/04	0.050	14.0	16.0	73	5.5	21	55.0
11/16/04	0.051	4.6	9.4	54	7.2	26	79.0
11/18/04	0.100	11.0	16.0	97	3.9	25	52.0
11/24/04	0.140	66.0	25.0	180	7.5	60	77.0
11/30/04	0.028	35.0	14.0	88	2.4	14	33.0
12/6/04	0.033	24.0	14.0	85	6.7	42	99.0
12/10/04	0.130	69.0	26.0	140	4.2	30	58.0
12/21/05	0.110	38.0	18.0	97	4.6	23	87.0
12/30/04	0.024	5.6	5.8	44	3.2	22	63.0
2/4/05	0.100	37.0	23.0	88	6.8	20	27.0
3/17/05	0.072	54.0	41.0	160	13.0	39	29.0
3/28/05	0.048	18.0	16.0	57	12.0	37	93.0
4/8/05	0.074	51.0	22.0	94	6.9	28	55.0
Samples	13	13	13	13	13	13	13
Maximum	0.140	69.0	41.0	180	13.0	60	99.0
Minimum	0.024	4.6	5.8	44	2.4	14	27.0
Mean	0.074	32.9	18.9	97	6.5	30	62.0

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.050	1.6	1.6	13	1.5	8	51.0
11/2/04	0.050	1.6	1.4	8	1.6	7	44.0
11/16/04	0.050	1.4	1.2	33	0.5	19	59.0
11/18/04	0.010	1.4	2.1	20	1.1	12	47.0
11/24/04	0.016	1.0	2.0	32	1.5	28	53.0
11/30/04	0.050	1.2	3.0	23	2.7	12	46.0
12/6/04	0.050	1.4	1.9	32	1.3	25	57.0
12/21/05	0.015	2.8	1.2	21	1.4	14	59.0
12/30/04	0.021	2.0	0.5	17	0.5	8	51.0
2/4/05	0.015	4.8	1.7	22	1.2	8	79.0
3/17/05	0.022	3.6	1.6	73	0.5	59	120.0
3/28/05	0.014	2.4	3.4	29	2.8	23	85.0
4/8/05	0.050	1.6	2.7	13	2.1	7	50.0
Samples	13	13	13	13	13	13	13
Maximum	0.050	4.8	3.4	73	2.8	59	120.0
Minimum	0.010	1.0	0.5	8	0.5	7	44.0
Mean	0.032	2.1	1.9	26	1.4	18	62.0

Chambered Vault SR 525 MP 4.1

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.022	3.4	5.2	39	4.3	24	150.0
11/1/04	0.050	3.8	4.9	50	3.1	30	160.0
11/16/04	0.050	1.0	2.3	34	1.2	17	160.0
12/21/05	0.010	3.0	1.1	26	1.2	14	140.0
12/30/04	0.120	66.0	17.0	110	1.7	25	36.0
3/28/05	0.039	10.0	17.0	54	11.0	34	29.0
4/8/05	0.440	310.0	65.0	350	8.5	42	49.0
5/16/05	0.270	100.0	34.0	170	9.1	37	28.0
5/18/05	0.049	10.0	12.0	56	6.6	32	23.0
Samples	9	9	9	9	9	9	9
Maximum	0.440	310.0	65.0	350	11.0	42	160.0
Minimum	0.010	1.0	1.1	26	1.2	14	23.0
Mean	0.117	56.4	17.6	99	5.2	28	86.1

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.050	0.4	2.9	39	2.9	22	43.0
11/2/04	0.039	10.0	3.9	45	1.9	22	52.0
11/16/04	0.027	1.8	3.6	58	2.0	34	100.0
12/9/04	0.050	4.0	3.9	48	2.1	30	49.0
12/10/04	0.014	4.0	5.0	53	1.4	34	41.0
12/30/04	0.039	2.6	2.1	47	0.6	28	51.0
3/28/05	0.024	10.0	9.4	50	6.3	31	43.0
4/8/05	0.026	13.0	8.0	60	2.8	30	42.0
5/18/05	0.027	3.0	6.3	33	3.9	23	35.0
Samples	9	9	9	9	9	9	9
Maximum	0.050	13.0	9.4	60	6.3	34	100.0
Minimum	0.014	0.4	2.1	33	0.6	22	35.0
Mean	0.033	5.4	5.0	48	2.7	28	50.6

Closed Vault SR 405 MP 26

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/13/03	0.017	0.9	4.6	18	2.7	9	37.0
12/16/03	0.021	1.2	3.9	24	3.2	20	37.0
1/8/04	0.048	4.5	5.5	42	3.8	38	45.0
1/15/04	0.019	3.6	4.4	29	3.5	18	34.0
1/26/04	0.028	3.3	4.5	17	4.4	16	28.0
Samples	5	5	5	5	5	5	5
Maximum	0.048	4.5	5.5	42	4.4	38	45.0
Minimum	0.017	0.9	3.9	17	2.7	9	28.0
Mean	0.027	2.7	4.6	26	3.5	20	36.2

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/16/03	0.026	1.5	4.4	33	3.8	18	37.0
1/8/04	0.048	5.0	4.4	47	3.7	47	38.0
1/15/04	0.010	2.9	3.2	23	2.8	16	33.0
1/26/04	0.053	14.0	5.4	26	5.0	19	22.0
1/30/04	0.048	12.0	4.1	19	3.3	13	22.0
2/17/04	0.027	1.8	3.9	17	2.9	11	32.0
Samples	6	6	6	6	6	6	6
Maximum	0.053	14.0	5.4	47	5.0	47	38.0
Minimum	0.010	1.5	3.2	17	2.8	11	22.0
Mean	0.035	6.2	4.2	28	3.6	21	30.7

Open Vault SR 405 MP 29.5

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/8/04	2.050	1416.0	220.0	1200	18.0	68	94.0
1/15/04	0.146	86.0	38.0	250	9.4	74	69.0
1/26/04	0.664	792.0	61.0	350	2.0	27	17.0
1/30/04	0.259	290.0	35.0	190	4.7	45	18.0
3/4/04	0.127	83.0	28.0	130	8.5	46	30.0
10/25/04	0.020	13.0	18.0	100	9.7	61	30.0
11/1/04	0.230	16.0	11.0	55	7.1	39	23.0
11/2/04	0.130	110.0	23.0	120	2.4	24	9.3
11/16/04	0.160	13.0	38.0	180	10.0	66	29.0
11/24/04	0.160	96.0	41.0	210	10.0	94	31.0
11/30/04	0.085	3.4	21.0	120	8.6	71	32.0
12/6/04	0.042	87.0	28.0	170	5.7	60	41.0
12/9/04	0.170	120.0	39.0	200	5.9	60	23.0
12/10/04	0.150	83.0	46.0	210	8.3	68	35.0
12/30/04	0.120	120.0	50.0	250	14.0	100	50.0
2/4/05	0.190	92.0	42.0	170	8.3	31	21.0
3/17/05	0.057	40.0	22.0	100	9.8	36	58.0
3/21/05	0.160	130.0	32.0	130	17.0	63	55.0
3/28/05	0.012	20.0	12.0	48	8.0	30	13.0
3/29/05	0.056	24.0	17.0	86	9.2	45	78.0
4/8/05	0.170	72.0	29.0	130	12.0	53	46.0
4/11/05	0.020	2.8	10.0	53	5.7	28	21.0
5/18/05	0.110	5.2	27.0	91	13.0	50	23.0
Samples	23	23	23	23	23	23	23
Maximum	2.050	1416.0	220.0	1200	18.0	100	94.0
Minimum	0.012	2.8	10.0	48	2.0	24	9.3
Mean	0.230	161.5	38.6	198	9.0	54	36.8

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/16/03	0.044	7.5	12.0	67	7.1	52	35.0
12/20/03	0.047	15.0	11.0	74	6.2	48	35.0
2/9/04	0.044	12.0	12.0	71	8.5	47	41.0
2/16/04	0.035	6.4	10.0	57	7.8	41	42.0
2/17/04	0.052	9.7	12.0	64	7.8	41	42.0
2/27/04	0.073	18.0	13.0	73	7.0	44	48.0
3/4/04	0.081	14.0	11.0	59	6.9	39	44.0
11/24/04	0.040	18.0	14.0	67	7.3	53	31.0
11/30/04	0.050	6.2	11.0	48	8.2	38	30.0
12/6/04	0.050	5.0	8.6	59	6.3	46	37.0
12/9/04	0.036	6.0	9.5	61	6.0	39	39.0
12/10/04	0.050	9.0	13.0	58	6.9	43	36.0
12/30/04	0.044	12.0	11.0	70	5.7	49	34.0
2/4/05	0.059	27.0	18.0	100	9.1	50	75.0
3/21/05	0.062	11.0	13.0	53	8.7	28	62.0
3/28/05	0.011	3.8	11.0	36	8.4	25	49.0
3/29/05	0.022	8.8	13.0	51	7.3	31	34.0
4/8/05	0.030	12.0	11.0	51	7.3	38	32.0
4/11/05	0.021	5.3	9.4	44	7.2	29	31.0
5/18/05	0.014	1.2	7.6	41	7.6	28	31.0
Samples	20	20	20	20	20	20	20
Maximum	0.081	27.0	18.0	100	9.1	53	75.0
Minimum	0.011	1.2	7.6	36	5.7	25	30.0
Mean	0.043	10.4	11.6	60	7.4	40	40.4

WSDOT was unable to directly collect inflow samples to this BMP. See Closed Vault SR 405 MP 26 for Untreated Runoff values.

Bioswale SR 405 MP 26

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.056	4.5	7.4	23	4.8	10	35.0
12/20/03	0.045	0.8	6.2	16	5.9	15	42.0
1/15/04	0.005	3.2	6.7	26	5.1	16	39.0
1/26/04	0.043	2.3	6.0	16	5.8	13	35.0
1/30/04	0.053	3.0	4.5	14	4.3	12	20.0
2/9/04	0.057	15.0	8.3	24	6.3	12	29.0
2/16/04	0.051	1.9	6.0	17	5.2	11	30.0
2/17/04	0.027	6.8	6.3	20	4.9	9	29.0
2/27/04	0.045	3.3	9.0	24	5.5	15	41.0
3/4/04	0.051	2.4	7.9	25	6.2	16	38.0
Samples	10	10	10	10	10	10	10
Maximum	0.057	15.0	9.0	26	6.3	16	42.0
Minimum	0.005	0.8	4.5	14	4.3	9	20.0
Mean	0.043	4.3	6.8	21	5.4	13	33.8

Dry Pond I-5 MP 188

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.022	3.0	4.4	37	3.3	31	10.0
12/13/03	0.015	1.8	6.2	52	4.0	44	16.0
12/16/03	0.025	3.2	6.0	58	4.1	49	21.0
12/20/03	0.016	1.7	5.9	61	4.8	53	18.0
1/8/04	0.199	33.0	19.0	200	7.5	95	35.0
1/15/04	0.019	4.8	6.7	49	6.9	39	15.0
1/26/04	0.014	0.8	4.0	33	3.6	28	10.0
2/5/04	0.018	0.4	4.4	52	3.9	37	15.0
3/4/04	0.033	1.0	6.8	53	4.6	33	13.0
3/10/04	0.034	2.0	7.6	31	5.7	20	10.0
5/24/04	0.067	5.2	20.0	58	18.0	54	21.0
5/26/04	0.020	4.0	14.0	47	12.0	43	16.0
Samples	12	12	12	12	12	12	12
Maximum	0.199	33.0	20.0	200	18.0	95	35.0
Minimum	0.014	0.4	4.0	31	3.3	20	10.0
Mean	0.040	5.1	8.8	61	6.5	44	16.7

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.017	1.5	3.2	29	2.5	22	16.0
12/13/03	0.018	2.3	4.4	33	2.8	21	13.0
12/16/03	0.019	2.5	3.2	25	2.7	21	14.0
1/8/04	0.045	5.5	6.4	41	2.9	21	14.0
1/15/04	0.020	2.0	2.0	38	2.5	32	18.0
1/26/04	0.034	6.0	3.4	29	2.8	24	18.0
1/30/04	0.020	2.0	2.7	22	2.6	24	15.0
2/5/04	0.018	2.0	3.1	24	2.2	20	17.0
2/9/04	0.018	2.4	2.7	30	2.3	20	18.0
2/17/04	0.062	9.2	4.2	16	2.8	12	17.0
2/27/04	0.033	8.0	4.2	13	2.5	3	15.0
3/4/04	0.046	8.0	4.5	27	3.1	16	13.0
3/10/04	0.035	4.4	4.2	20	3.2	12	12.0
Samples	13	13	13	13	13	13	13
Maximum	0.062	9.2	6.4	41	3.2	32	18.0
Minimum	0.017	1.5	2.0	13	2.2	3	12.0
Mean	0.030	4.3	3.7	27	2.7	19	15.4

Dry Pond I-5 MP 122 (all water infiltrated)

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/10/04	0.016	25.0	13.5	135	3.4	81	13.5
12/13/04	0.120	86.0	28.0	210	5.2	110	20.0
1/17/05	0.230	185.0	45.0	163	3.6	78	20.0
1/18/05	0.110	76.0	22.0	130	1.4	46	9.5
Samples	4	4	4	4	4	4	4
Maximum	0.230	185.0	45.0	210	5.2	110	20.0
Minimum	0.016	25.0	13.5	130	1.4	46	9.5
Mean	0.119	93.0	27.1	160	3.4	79	15.8

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
9/11/04	NS	NS	NS	NS	NS	NS	NS
10/8/04	NS	NS	NS	NS	NS	NS	NS
10/22/04	NS	NS	NS	NS	NS	NS	NS
10/25/04	NS	NS	NS	NS	NS	NS	NS
10/30/04	NS	NS	NS	NS	NS	NS	NS
11/2/04	NS	NS	NS	NS	NS	NS	NS
11/10/04	NS	NS	NS	NS	NS	NS	NS
11/18/04	NS	NS	NS	NS	NS	NS	NS
11/26/04	NS	NS	NS	NS	NS	NS	NS
12/4/04	NS	NS	NS	NS	NS	NS	NS
12/9/04	NS	NS	NS	NS	NS	NS	NS
12/13/04	NS	NS	NS	NS	NS	NS	NS
1/7/05	NS	NS	NS	NS	NS	NS	NS
1/17/05	NS	NS	NS	NS	NS	NS	NS
1/18/05	NS	NS	NS	NS	NS	NS	NS
Samples	0	0	0	0	0	0	0
Maximum	0.000	0.0	0.0	0	0.0	0	0.0
Minimum	0.000	0.0	0.0	0	0.0	0	0.0
Mean	0.000	0.0	0.0	0	0.0	0	0.0

WSDOT was unable to directly collect inflow samples to this BMP. See Wet Pond SR 525 MP 3.3 for Untreated Runoff values.

Unimproved Ditch SR 525 MP 2.1

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
10/25/04	0.023	1.4	11.0	35	11.0	20	41.0
11/2/04	0.034	3.0	9.0	29	6.3	21	40.0
11/24/04	0.120	5.4	8.8	47	6.0	29	38.0
12/9/04	0.050	2.2	4.5	19	4.1	13	41.0
12/21/05	0.070	5.8	5.9	35	4.6	16	45.0
12/30/04	0.022	3.0	4.2	21	2.3	14	43.0
3/28/05	0.032	1.6	6.1	20	4.5	11	23.0
5/16/05	0.026	3.8	6.9	23	6.6	17	23.0
5/18/05	0.028	2.2	7.8	31	7.2	14	43.0
Samples	9	9	9	9	9	9	9
Maximum	0.120	5.8	11.0	47	11.0	29	45.0
Minimum	0.022	1.4	4.2	19	2.3	11	23.0
Mean	0.045	3.2	7.1	29	5.8	17	37.4

WSDOT was unable to directly collect inflow samples to this BMP. See Open Vault SR 405 MP 29.5 for Untreated Runoff values.

Unimproved Ditch SR 405 MP 27.7

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
12/5/03	0.048	0.3	6.7	62	5.8	55	27.0
12/13/03	0.044	0.5	6.1	68	5.7	59	29.0
12/16/03	0.053	2.3	6.7	64	5.6	70	27.0
12/20/03	0.031	0.3	7.4	75	6.2	72	30.0
11/2/04	0.057	5.6	6.7	53	6.7	48	13.0
11/30/04	0.050	1.8	8.5	62	8.5	58	26.0
12/6/04	0.050	2.6	8.2	66	6.6	65	28.0
12/9/04	0.044	2.0	5.2	60	6.0	50	26.0
12/10/04	0.051	1.0	7.7	52	4.6	46	24.0
12/30/04	0.076	1.4	3.8	51	3.3	40	23.0
3/28/05	0.056	1.8	9.5	50	9.8	49	26.0
4/8/05	0.028	0.4	7.3	51	6.6	39	28.0
Samples	12	12	12	12	12	12	12
Maximum	0.076	5.6	9.5	75	9.8	72	30.0
Minimum	0.028	0.3	3.8	50	3.3	39	13.0
Mean	0.049	1.7	7.0	60	6.3	54	26.0

Ecology Embankment SR 167

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/1/04	0.029	67.0	32.0	220	12.0	110	33.0
11/2/04	0.100	49.0	45.0	300	11.0	96	41.0
11/16/04	0.370	210.0	87.0	520	16.0	140	49.0
11/24/04	0.280	68.0	50.0	440	11.0	150	53.0
11/30/04	0.048	76.0	41.0	290	5.7	86	17.0
12/9/04	0.072	87.0	32.0	230	11.0	100	23.0
12/10/04	0.031	190.0	80.0	500	8.3	120	51.0
12/13/04	0.420	150.0	110.0	620	7.5	83	46.0
12/27/04	0.190	38.0	39.0	270	18.0	170	71.0
12/30/04	0.390	140.0	62.0	480	11.0	170	76.0
1/18/05	0.260	100.0	54.0	460	23.0	270	110.0
3/1/05	0.540	250.0	120.0	560	33.0	200	77.0
3/17/05	0.046	370.0	94.0	630	23.0	120	56.0
3/28/05	0.180	16.0	27.0	150	17.0	110	25.0
4/8/05	0.520	99.0	93.0	440	13.0	98	34.0
4/11/05	0.130	22.0	38.0	190	20.0	120	32.0
Samples	16	16	16	16	16	16	16
Maximum	0.540	370.0	120.0	630	33.0	270	110.0
Minimum	0.029	16.0	27.0	150	5.7	83	17.0
Mean	0.225	120.8	62.8	394	15.0	134	50.0

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/2/04	0.050	10.0	9.6	98	6.0	63	14.0
11/16/04	0.050	2.0	12.0	63	10.0	43	27.0
12/9/04	0.014	2.4	9.0	38	7.1	34	29.0
12/10/04	0.041	4.2	11.0	35	6.5	23	27.0
12/13/04	0.041	13.0	11.0	35	4.7	15	19.0
12/27/04	0.018	2.4	12.0	35	8.3	24	35.0
12/30/04	0.039	0.4	6.0	30	5.0	25	36.0
1/18/05	0.050	0.4	5.2	30	3.2	22	63.0
3/1/05	0.028	10.0	8.5	26	7.9	20	56.0
3/17/05	0.040	22.0	26.0	69	22.0	46	39.0
3/28/05	0.027	2.8	15.0	31	14.0	30	31.0
4/8/05	0.014	2.4	9.8	54	7.7	23	33.0
4/11/05	0.050	0.4	7.1	20	6.9	16	34.0
Samples	13	13	13	13	13	13	13
Maximum	0.050	22.0	26.0	98	22.0	63	63.0
Minimum	0.014	0.4	5.2	20	3.2	15	14.0
Mean	0.036	5.6	10.9	43	8.4	30	34.0

Compost Shoulder I-5

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
11/23/03	0.110	58.0	29.0	140	5.6	53	16.0
12/5/03	0.214	90.0	38.0	200	6.7	94	27.0
12/13/03	0.179	120.0	28.0	150	4.1	60	12.0
1/23/04	0.411	342.0	62.0	310	5.7	63	34.0
1/28/04	0.227	170.0	38.0	190	3.8	51	24.0
2/13/04	0.219	100.0	40.0	200	10.0	88	37.0
3/5/04	0.299	190.0	45.0	240	5.4	70	28.0
3/19/04	0.084	280.0	59.0	290	12.0	90	33.0
3/24/04	0.360	190.0	36.0	190	7.2	69	20.0
Samples	9	9	9	9	9	9	9
Maximum	0.411	342.0	62.0	310	12.0	94	37.0
Minimum	0.084	58.0	28.0	140	3.8	51	12.0
Mean	0.234	106.4	41.7	109	6.7	48	25.7

Sample Date	TP	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn	HA
1/1/03	NS	9.0	NS	NS	NS	NS	NS
1/23/03	NS	NS	NS	NS	NS	NS	NS
1/30/03	NS	NS	NS	NS	NS	NS	NS
2/14/03	0.300	12.0	8.2	32	5.8	24	19.0
2/18/2003*	NS	12.0	6.8	24	ND	16	19.0
3/21/03	0.200	14.0	8.5	29	6.0	19	26.0
3/25/03	0.210	10.0	7.2	27	5.4	25	21.0
4/4/03	0.260	100.0	17.0	52	5.8	20	19.0
4/7/03	0.280	11.0	8.1	25	5.8	17	21.0
11/16/03	0.400	9.0	7.9	33	**	**	18.0
11/17/03	0.340	6.0	7.3	30	6.6	23	23.0
11/28/03	0.200	2.8	7.6	33	5.4	18	16.0
12/5/03	0.307	6.5	6.9	36	4.5	15	19.0
12/13/03	0.262	5.2	5.7	69	4.9	22	17.0
1/1/04	0.280	12.0	8.3	30	4.8	18	19.0
2/13/04	0.243	6.8	6.3	29	4.8	20	18.0
3/5/04	0.286	34.0	14.0	58	7.5	29	23.0
Samples	13	15	14	14	12	13	14
Maximum	0.400	100.0	17.0	69	7.5	29	26.0
Minimum	0.200	2.8	5.7	24	4.5	15	16.0
Mean	0.274	16.7	8.6	36	5.6	20	19.9

*Sample date reported incorrectly in 2004 NPDES report. Date has been amended.

**Samples were not preserved properly.

Appendix 6-B Fecal and Grab Sampling Locations

Untreated Highway Runoff			
Grab Sample Location	**State Route & Nearest Town**	**Land Use**	**ADT**
Natural runoff channel near 113th Avenue	121, Tumwater	Rural	5,000
Inlet to Chambered Vault MP 4.1	525, Mukilteo	Urban	20-40,000
Inlet to Wet Pond MP 3.3	525, Mukilteo	Urban	20-40,000
Inlet to Open Wet Vault MP 29.5	405, Bothell	Urban	80-100,000
Inlet to Wet Pond MP 96.2	5, Tumwater	Urban	90,000
Untreated Run-On to Highway			
Forested wetland area	121, Tumwater	Rural	5,000
Ditch in front of horse ranch	121, Tumwater	Rural	5,000
Residential run-on	525, Mukilteo	Urban	20-40,000
Commercial run-on	525, Mukilteo	Urban	20-40,000
BMP Treated Runoff			
Outlet from Unimproved Ditch MP 2.1	525, Mukilteo	Urban	20-40,000
Outlet from Wet Pond MP 3.3	525, Mukilteo	Urban	20-40,000
Outlet from Open Wet Vault MP 29.5	405, Bothell	Urban	80-100,000
Unimproved Grass Ditch MP 27.7	405, Bothell	Urban	80-100,000

Appendix 6-C Fecal and Grab Sample Data

NS means No Sample was collected
TP stands for Total Phosphorus
HA stands for Hardness
TSS stands for Total Suspended Solids
Values in grey represent No Detection and are reported as half the detection limit.

Untreated Highway Runoff

Untreated Runoff - SR 121

Sample Date	E. Coli #/100 ml	Fecal Coliform #/100 ml	TP mg/L	HA mg/L	TSS mg/L	Total Cu ug/L	Total Zn ug/L	Dis. Cu ug/L	Dis. Zn ug/L
12/9/2004	NS	25	0.065	19	6.6	3.7	16	1.1	7.5
12/10/2004	NS	50							
12/10/2004	NS	80							
1/12/2005	NS	15	0.260	53	32	3.8	22	2.4	9.6
1/12/2005	NS	33							
1/12/2005	NS	20							
1/17/2005	NS	10	0.140	16	10	3.8	12	1.1	5.4
1/18/2005	NS	< 5							
1/18/2005	NS	< 5							
2/6/2005	NS	10	0.091	59	26	1.7	17	0.5	5.3
2/6/2005	NS	5							
2/6/2005	NS	100							
2/28/2005	NS	<5	1.1	88	NS	1.9	16	0.5	6.6
3/1/2005	NS	<5							
3/2/2005	NS	10							
3/16/2005	NS	700							
3/20/2005	NS	105	0.092	26	49	5.6	27	3.4	8.5
3/20/2005	NS	20							
3/20/2005	NS	95							

Inlet to Chambered Vault - SR 525

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	170	170	0.15	26	250	25	140	2.8	21
1/17/2005	70	70							
2/4/2005	90	90	0.13	26	67	20	90	7.4	24
2/4/2005	500	900							
3/16/2005	300	300	0.13	28	64	30	100	13	34
3/29/2005	130	130	0.035	31	902	10	38	5.3	16
4/7/2005	900	900	0.052	26	74	21	98	4	26
4/7/2005	220	220							

Inlet to Wet Pond - SR 525

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	170	170	0.14	26	120	28	140	5.8	32
1/17/2005	170	140							
2/4/2005	130	240	0.2	24	48	22	86	6.6	17
2/4/2005	70	500							
3/16/2005	80	80	0.027	27	100	41	140	12	29
3/29/2005	80	80	0.034	31	6.8	13	43	7.1	19
4/7/2005	39	220	0.063	23	56	24	94	5.5	17
4/7/2005	300	300							

Inlet to Open Vault - SR 405

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	1600	1600	0.79	42	340	85	410	8.6	38
1/17/2005	11	11							
2/4/2005	240	240	0.13	25	46	35	110	12	38
2/4/2005	1600	1600							
3/16/2005	170	170	0.17	31	170	73	270	19	67
3/20/2005	500	500	0.11	48	44	30	120	14	55
3/28/2005	500	900	0.21	68	37	39	160	18	98
3/29/2005	240	300	0.026	32	4.8	11	56	6.4	39
4/7/2005	350	350	0.13	34	88	50	220	12	35
4/7/2005	300	300							

Inlet to Wet Pond - I-5

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
12/9/2004	NS	900	0.190	21	120	41	210	4	61
12/10/2004	NS	1200							
12/10/2004	NS	850							
1/12/2005	NS	1400	0.800	68	370	100	630	5.5	92
1/12/2005	NS	900							
1/12/2005	NS	500							
1/17/2005	NS	400	0.160	33	75	32	170	6.8	74
1/18/2005	NS	200							
1/18/2005	NS	100							
2/6/2005	NS	650	0.059	26	10	11	92	3.5	49
2/6/2005	NS	700							
2/6/2005	NS	700							
2/28/2005	NS	300	0.37	37	260	66	360	8.2	62
3/1/2005	NS	500							
3/2/2005	NS	400							
3/16/2005	NS	840	0.17	93	160	80	480	32	250
3/16/2005	NS	640							
3/16/2005	NS	2200							
3/20/2005	NS	119	0.005	11	10	6.9	64	2.2	36
3/20/2005	NS	81							
3/20/2005	NS	1400							

Untreated Run-on to Highway

Forested Wetland - SR 121

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
12/9/2004	NS	75	0.110	20	8.8	4.3	17	0.5	6.1
12/10/2004	NS	65							
12/10/2004	NS	75							
1/12/2005	NS	< 5	0.240	19	12	1.1	14	0.5	2.5
1/12/2005	NS	10							
1/12/2005	NS	5							
1/17/2005	NS	85	0.067	16	4.5	1.9	13	0.5	2.5
1/18/2005	NS	115							
1/18/2005	NS	85							
2/6/2005	NS	15	0.12	20	19	1.8	14	0.5	7.6
2/6/2005	NS	5							
2/6/2005	NS	10							
2/28/2005	NS	<5	0.21	20	8	0.5	6.6	0.5	7.4
3/1/2005	NS	<5							
3/2/2005	NS	<10							
3/16/2005	NS	<5	0.14	23	36	3.6	24	2.5	8
3/16/2005	NS	<5							
3/16/2005	NS	10							
3/20/2005	NS	276	0.13	32	55	4	23	1.8	10
3/20/2005	NS	210							
3/20/2005	NS	190							

Ditch near horse ranch - SR 121

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
12/9/2004	NS	135	0.160	51	12	3.1	21	0.5	8.1
12/10/2004	NS	40							
12/10/2004	NS	35							
1/12/2005	NS	200	0.087	36	47	0.5	11	0.5	2.5
1/12/2005	NS	15							
1/12/2005	NS	45							
1/17/2005	NS	40	0.044	33	1.6	3.5	16	0.5	5.5
1/18/2005	NS	500							
1/18/2005	NS	700							
2/6/2005	NS	<5	0.23	37	10	0.5	20	0.5	7.1
2/6/2005	NS	<5							
2/6/2005	NS	10							
2/28/2005	NS	45	0.19	39	6	0.5	16	0.5	2.5
3/1/2005	NS	520							
3/2/2005	NS	70							
3/16/2005	NS	70	0.12	42	9.2	0.5	11	0.5	7.4
3/16/2005	NS	60							
3/16/2005	NS	50							
3/20/2005	NS	229	0.052	40	38	0.5	14	0.5	5.7
3/20/2005	NS	1200							
3/20/2005	NS	1700							

SR 525 Residential

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	30	30	0.022	28	2.8	1.9	100	0.5	74
1/17/2005	70	70							
2/4/2005	900	900	0.019	17	4.4	2.2	73	2	54
2/4/2005	1600	1600							
3/16/2005	1600	1600	0.074	23	19	6.8	100	4.3	76
3/20/2005	300	300	0.042	25	3	2.1	67	1.7	56
3/29/2005	140	140	0.005	36	202	2.3	64	1.9	63
4/7/2005	23	23	0.019	15	9.8	2.4	85	1.3	65
4/7/2005	30	30							

SR 525 Commercial

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	220	220	0.18	14	28	7.2	80	1.5	31
1/17/2005	1600	1600							
2/4/2005	220	220	0.13	13	9.2	4.1	62	2.2	31
2/4/2005	240	240							
3/16/2005	300	300	0.15	31	21	9.4	220	4.9	160
3/20/2005	500	500	0.093	19	6.2	5.9	70	4	56
3/29/2005	240	240	0.044	21	3.2	6.8	95	4	68
3/29/2005	220	220							
4/7/2005	220	280	0.037	14	6.8	4.9	160	2.8	46
4/7/2005	500	500							

BMP Treated Runoff

Outlet from Unimproved Ditch - SR 525

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	17	17	0.029	45	5.8	5.4	23	2.9	10
1/17/2005	4	4							
2/4/2005	500	500	0.12	31	11	8.4	24	7.3	12
2/4/2005	13	13							
3/16/2005	240	240	0.16	70	5.2	10	18	8.1	11
3/20/2005	4	4	0.06	44	3.6	8	18	6.9	10
4/7/2005	23	23	0.014	39	2.4	7.7	16	6.5	11
4/7/2005	240	240							

Outlet from Pond -SR 525

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	1	1	0.014	57	4.0	0.5	6.1	0.5	2.5
1/17/2005	1	1							
2/4/2005	1	1	0.012	78	4.0	1.4	20.0	1.5	7.4
2/4/2005	4	4							
3/16/2005	2	2	0.014	120	3.6	0.5	30.0	0.5	31.0
3/16/2005	1	1							
3/29/2005	1	1	0.005	50	2.0	3.6	8.3	3.0	6.8
4/7/2005	11	11	0.005	50	1.0	1.6	12.0	1.8	5.1
4/7/2005	8	8							
4/7/2005	7	7							

Outlet from Open Vault - SR 405

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	220	220	0.12	110	60	26	150	11	67
1/17/2005	300	300							
2/4/2005	30	30	0.06	80	36	16	98	7.6	52
2/4/2005	80	130							
3/16/2005	13	23	0.11	71	32	14	58	7.2	21
3/28/2005	7	11	0.022	32	7.8	13	47	7.3	40
3/29/2005	50	50	0.045	33	9	12	52	8.4	29
4/7/2005	13	13	0.034	32	9	10	46	7	19
4/7/2005	23	23							

Oulet from Unimproved Grass Ditch - SR 405

Sample Date	E. Coli	Fecal Coliform	TP	HA	TSS	Total Cu	Total Zn	Dis. Cu	Dis. Zn
1/17/2005	1	1	0.014	57	0.4	3.7	71	2.6	55
1/17/2005	4	4							
2/4/2005	70	70							
4/7/2005	140	140	0.033	27	3.6	7.8	61	6.5	34

Appendix 7-A Stormwater Treatment Facility Construction

State Route	Project Name	Milepost or Station	Offset Direction	County	BMP Type	Facility Size
16	Burley-Olalla Intersection	EB Sta. 534+85 to 536+85	Right	Pierce	Bioswale	871 ft^2
	MP 19.74 to MP 20.22	EB Sta. 546+76 to 588+76	Left		Bioswale	871 ft^2
		EB Sta. 556+00 to 558+00	Right		Bioswale	871 ft^2
		EB Sta. 546+00	Left		Detention Pond	15,681 ft^3
166	Ross Point Vicinity Slide Repair MP 0.93 to MP 1.59	Main Sta. 68+50 to 71+90	Right	Pierce	Bioswale	5,663 ft^2
167	North Sumner Interchange	SR167 Sta. 15+806 to 15+861	Right	Pierce	Bioswale	871 ft^2
	MP 0.00 to MP 0.00	A24 Sta. 0+431 to 0+520	Right		Bioswale	1,742 ft^2
		A24 Sta. 0+917 to 0+995	Right		Bioswale	1,742 ft^2
		N-EW Sta. 0+100	Left		Detention Pond	4,356 ft^3
		N-EW Sta. 0+150	Left		Infiltration Pond	5,663 ft^3
104	JCT. SR 19 Intersection Safety MP 8.86 to MP 9.12	L Sta. 500+00 to 502+80	Left	Jefferson	Bioswale	1,307 ft^2
5	SR 501 Ramp Signals	MP 19.57 to MP 20.05	Left/Right	Clark	Natural Dispersion	2,400 ft
		MP 19.74 to MP 19.76	Left		Biofiltration Swale	415 ft^2
14	32nd Street Intersection Improvements	L 1899+63 to L 1900+98	Right	Clark	Ecology Embankment	1,620 ft^2
203	NE Stillwater Hill Rd & Fay Rd Channelization MP 8.69 to MP 9.75	Sta. 3+225 to 3+800	Left	King	Vault	575 ft
405	SE 8th Street Interchange Modifications	AL Line 9+880	Left	King	Wet Pond	*
	MP 12.42 to MP 12.92	LHSB 10+090	Right		Biofiltration Swale	846 ft
		LHSB 10+282 to 10+299	Right		Wet Vault	399 ft^2
405	NE 8th Street Undercrossing	Sta. 7+560 to 7+622.95	Right	King	Pond	49,400 ft^3
	MP 13.82	Sta. 7+800 to 7+898	Right		Pond	2,125 ft^3
5	196th Street	FB 5+00	Left	Snohomish	Detention/Wet Pond	35,700 ft^3
	MP 180.77 to MP 182.57	LL 507+00	Left		Detention/Wet Pond	22,400 ft^3
		NE 503+00 to 506+20	Right		Biofiltration Swale	320 ft
		LL 532+50 to LL 534+53	Left		Biofiltration Swale	203 ft
		LL 535+00	Left		Detention/Wet Pond	66,800 ft^3
9	SR 96 Vicinity to SR 204 Vicinity	Sta 53+85 to 55+60	Right	Snohomish	Vegetative Filter Strip	175 ft
	MP 7.11 to MP 17.92	Sta 58+05 to 59+30	Right		Vegetative Filter Strip	125 ft
525	Cameron Road to SR 20	Sta. C 43+001.92 to Sta. 43+095	Right	Island	Bioswale	93 ft
	MP 26.47 to MP 30.09	Sta. C 43+820 to Sta. 43+850	Left		Detention Pond	3,180 ft^2
		Sta. C 43+857.87 to Sta. 43+920	Left		Bioswale	59 ft
		Sta. C 44+360 to Sta. 44+410	Right		Bioswale	50 ft
		Sta. C 44+520 to Sta. 44+560	Left		Detention Pond	1,362 ft^2
		Sta. C 44+560 to Sta. 44+620	Right		Bioswale	60 ft
		Sta. C 45+210 to Sta. 45+240	Left		Detention Pond	2,104 ft^2
		Sta. C 45+900 to Sta. 45+980	Right		Bioswale	80 ft
		Sta. C 45+920 to Sta. 45+980	Left		Bioswale	60 ft
		Sta. C 46+494 to Sta. 46+554	Right		Bioswale	60 ft
		Sta. C 46+545 to Sta. 46+600	Left		Detention Pond	461 ft^2
		Sta. C 46+680 to Sta. 46+740	Right		Bioswale	60 ft
		Sta. C 10+270 to Sta. 10+330	Right		Bioswale	60 ft
		Sta. C 10+505 to Sta. 10+570	Right		Bioswale	65 ft
		Sta. C 10+570 to Sta. 10+618.6	Right		Bioswale	49 ft